Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

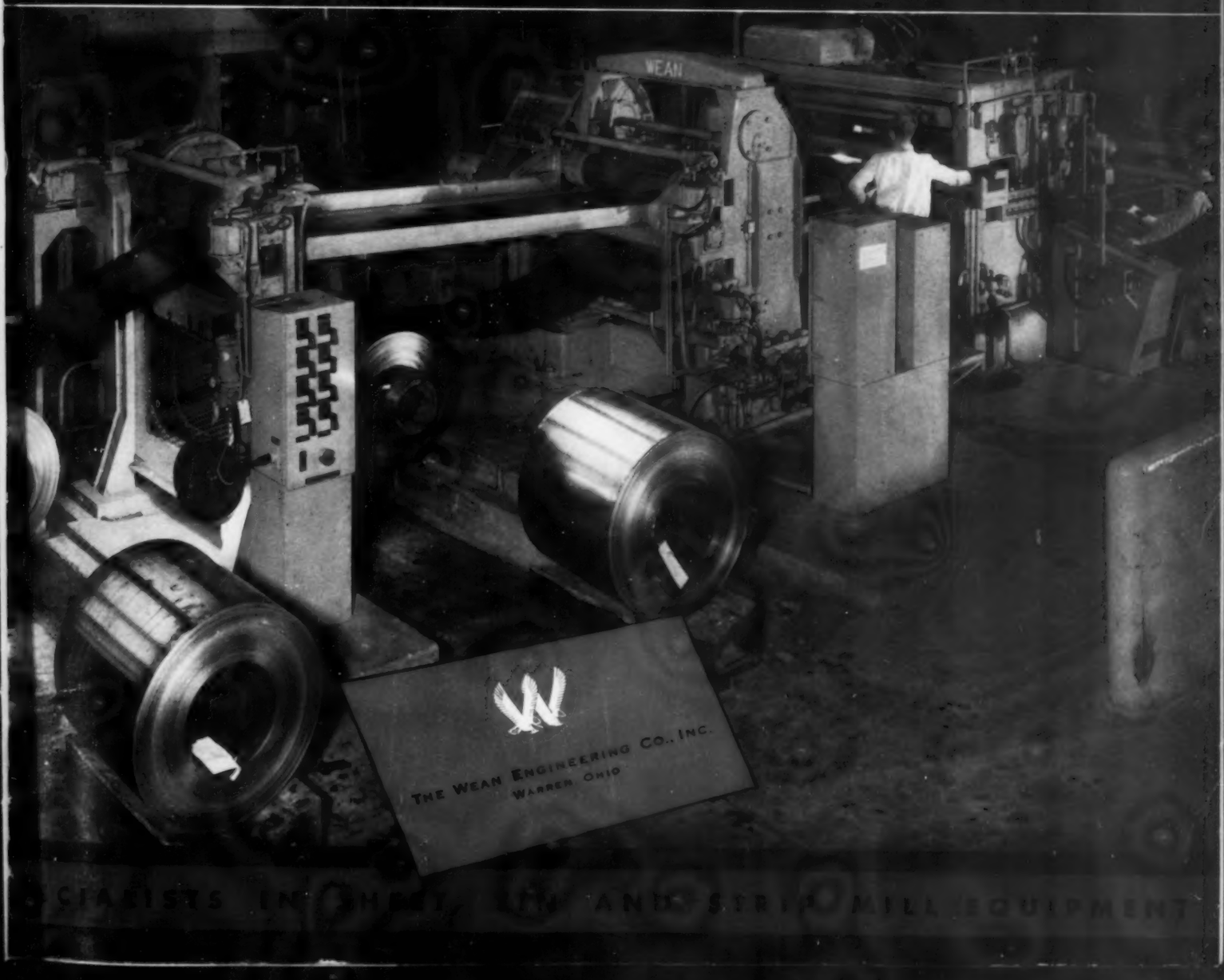
JULY, 1952

TABLE OF CONTENTS, Page 53

The WEAN

ENGINEERING COMPANY INC.

WARREN, OHIO



R v.29 July–Dec. 1952

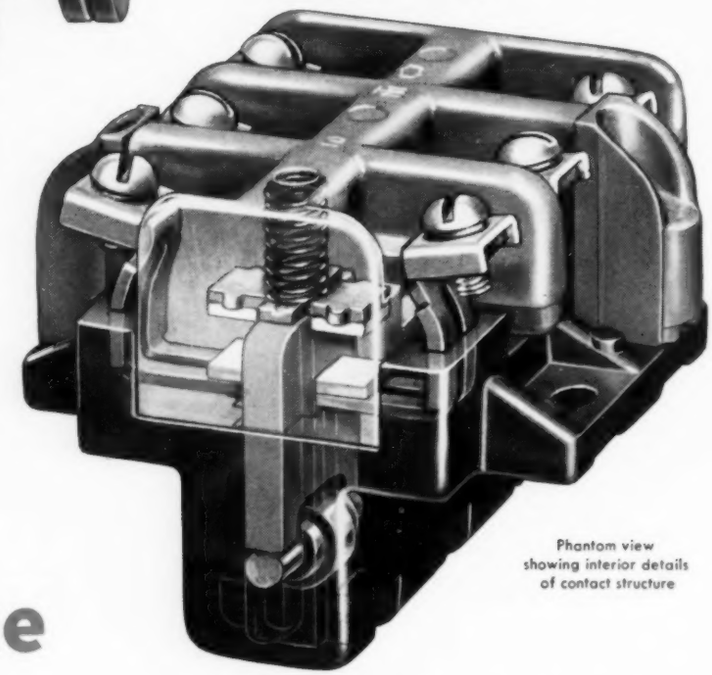
new CUTLER-HAMMER TRACK TYPE limit switches

(Bulletin 14977)

ROLLER LEVER SPRING RETURN SWITCH

FORK LEVER TWO POSITION SWITCH

Clamp-on type operating lever can be mounted at any angle on shaft. Also can be readily shifted to opposite end of shaft for right or left hand track installation. Overtravel provided in both directions. Cast iron NEMA 1 Standard, NEMA 4 Watertight or NEMA 5 Dusttight enclosures. Tapped for conduits. Contacts rated at 1.25 amps. at 250 volts d.c. Two pole or three pole with contacts normally open and/or normally closed, with or without overlap.



Phantom view showing interior details of contact structure

utilizing the all new simplified contact structure

STANDARDIZED . . . the identical contact structure used in many other Cutler-Hammer limit switches, mill accessory masters, foot switches, etc. It is *completely* interchangeable . . . simplifies spare parts and replacement problem.

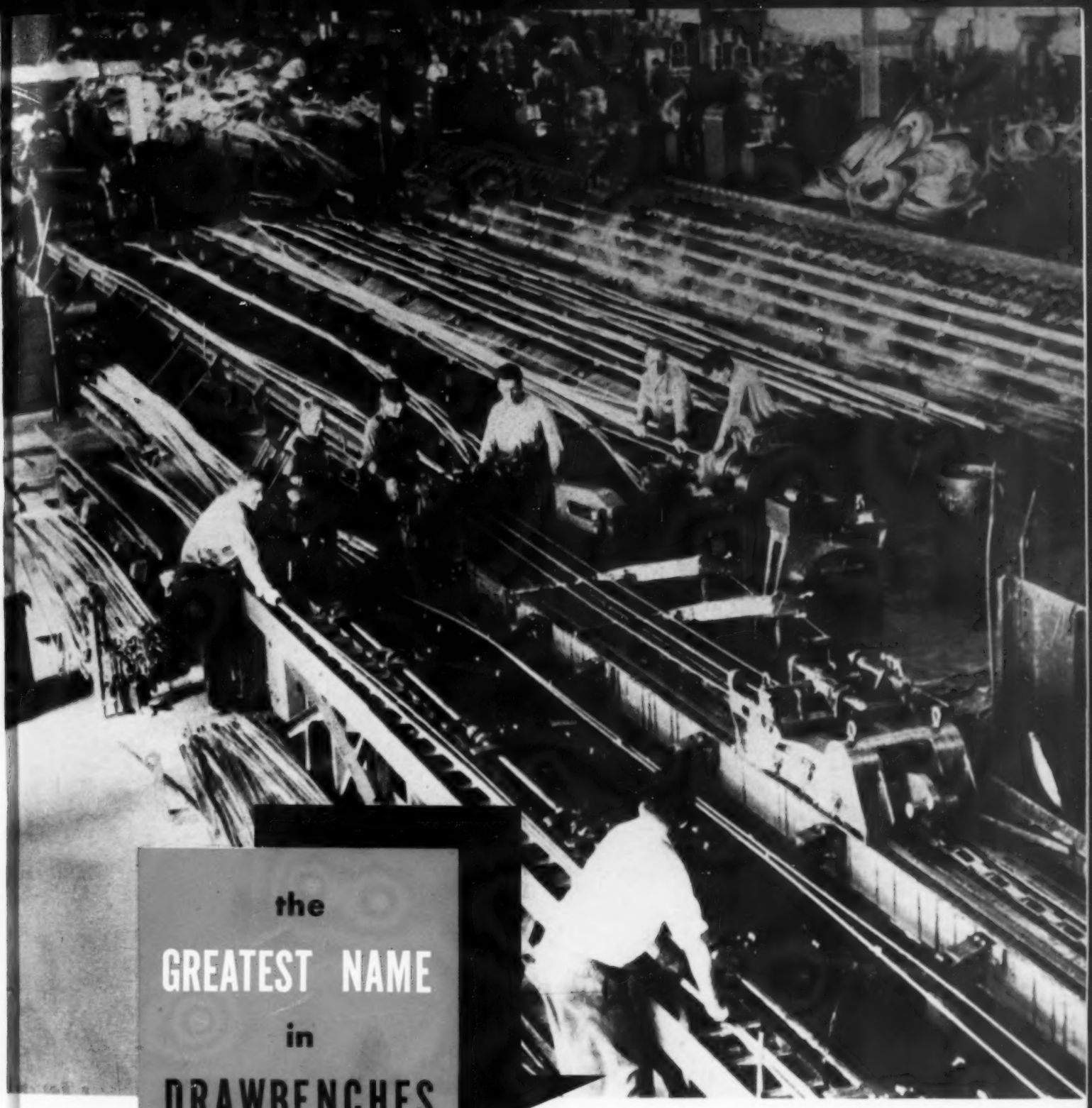
SIMPLIFIED . . . this contact structure is reduced to simplest elements, for easy understanding, for easy accessibility, for easy parts renewal.

STURDY . . . cam and roller actuated, long-lived, dependable. Small and compact. Many features, special alloy tips, arc-resistant molded supports, twin break contacts, etc., etc., etc. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER-HAMMER MOTOR CONTROL C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 7.

Tech



the
GREATEST NAME
in
DRAWBENCHES

Aetna-Standard

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.

Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

They did . . .

Weirton needed more production from this mill. The way to get it—a new drive.

what . . .

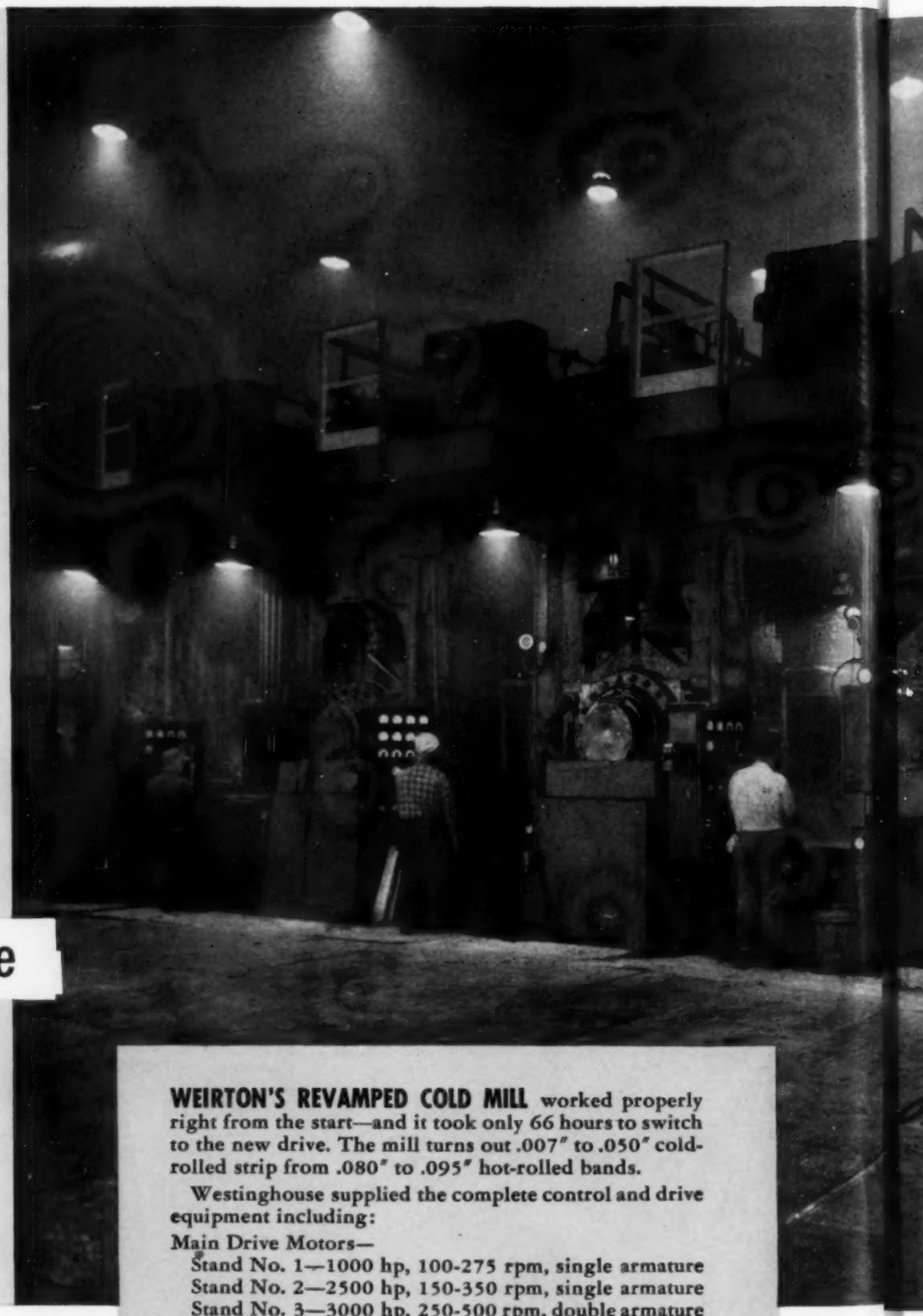
They called in Westinghouse to help engineer the drive. Based on our experience with similar installations, we attacked the problem *as a whole*—and helped them put together *a co-ordinated electrical system.*

you can do . . .

This experience and this method can be applied to *your* next project—whatever it is. Westinghouse can work with you on *all* your electrical needs.

to produce more

The result will be more production, lower costs, better operations—or a combination. Whether you need one motor, or a complex system, Westinghouse can come up with the answer.



WEIRTON'S REVAMPED COLD MILL worked properly right from the start—and it took only 66 hours to switch to the new drive. The mill turns out .007″ to .050″ cold-rolled strip from .080″ to .095″ hot-rolled bands.

Westinghouse supplied the complete control and drive equipment including:

Main Drive Motors—

Stand No. 1—1000 hp, 100-275 rpm, single armature
Stand No. 2—2500 hp, 150-350 rpm, single armature
Stand No. 3—3000 hp, 250-500 rpm, double armature
Stand No. 4—3000 hp, 312-625 rpm, double armature
Reel —600 hp, 180-720 rpm, double armature

Power for the drive motors is supplied by a new four-generator M-G set, along with one existing M-G set from the original drive. Each motor is fed by its own generator.

They sold the FIRST COIL they rolled on this revamped tandem mill!

Weirton Steel had Westinghouse build a complete new drive for this tandem cold strip mill—to boost the speed from 1500 to 3000 fpm. The mill was down only 66 hours for the change-over. And the first new coil they rolled was of salable quality!

PROBLEMS SOLVED AHEAD OF TIME

How were they able to do it in such a short time? It was based on previous Westinghouse strip mill experience. The operating and engineering problems were anticipated—and solved *ahead* of time.

TOTAL DOWNTIME FOR REVAMP: 66 HOURS

The new drive was built alongside the old one, according to an ingenious plan worked out by Weirton and Westinghouse engineers. They changed over while the mechanical equipment was being revamped. The mill was rolling 66 hours later—and it hasn't needed a major adjustment since then.

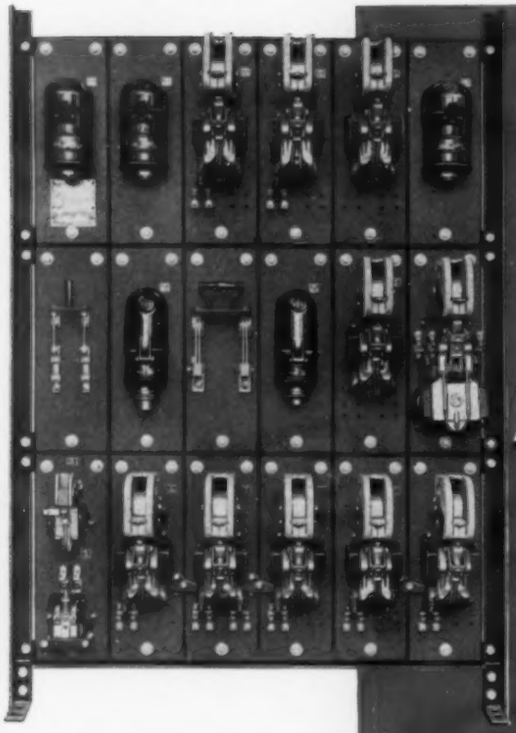
CALL WESTINGHOUSE EARLY ON EVERY JOB

This is the kind of thinking Westinghouse applies to *all* steel mill electrical projects. Whatever your next job is—a main mill drive, the equipment for an electrical furnace, an auxiliary motor—call your Westinghouse office early in the planning stage. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94899

YOU CAN BE SURE... IF IT'S

Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY



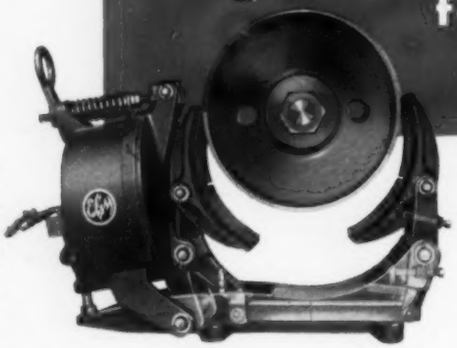
LOOK for these NAMES when buying Motor Control

1 LINE-ARC Contactors
2 TIME-CURRENT Acceleration (D-c)
3 FREQUENCY RELAY Acceleration (A-c)
4 WRIGHT CIRCUIT Hoist Control (D-c)
5 YOUNGSTOWN Hoist Limit Stops
6 TYPE WB Brakes
7 CAM Master Switches
8 MANUAL-MAGNETIC Disconnect Switches
9 CONTRA-TORQUE Hoist Control (A-c)
10 TAB-WELD Resistors

These FUNCTIONAL NAMES Speak for Themselves

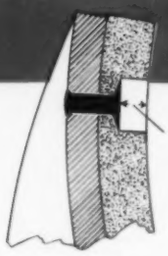
TYPE WB Brakes

Long Life Brakes for A-c and D-c Motors

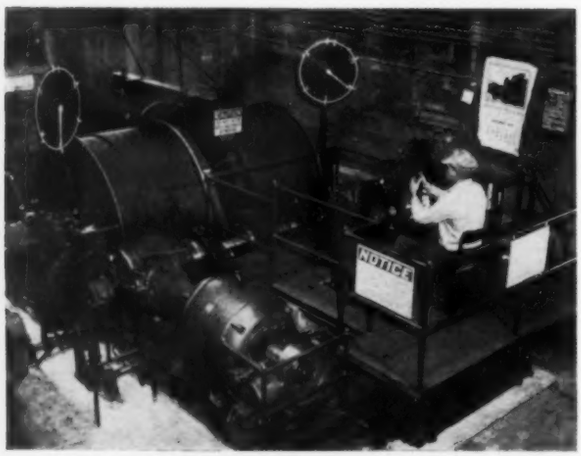


Type WB Brake showing how the motor armature is easily lifted out. At top left is the handle-nut for compressing the spring when removing motor armature, changing brake shoes and for manual control.

The brake lining is molded to match curvature of wheel and shoe.



Actual wearing thickness, between rivet heads and brake wheel is 1/8" on the smallest size to 7/16" on the largest size.



A-C Mine Hoist Motor with WB Brake.

These Type WB Brakes use a block type lining which is both thick and tough.

Furthermore, due to the process of manufacture, the blocks have proper frictional quality *throughout the entire thickness*, permitting uniform and complete wear down to rivet heads. And since the material is non-compressionable, brake adjustments are infrequent.

Write for Bulletins 1004 and 1006.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

MACHINE SHOPS at MESTA

DRAW-CUT SHAPERS . . .

Simultaneously Machining a Pair of Rolling Mill Housings on MESTA Heavy Duty Draw-Cut Shapers . . .

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY
Pittsburgh, Pa.

put YOURSELF in this picture

Be sure to attend the Big 1952 Iron and Steel Exposition this year. This exposition, held in conjunction with the AISE Convention, serves as an essential clearing house for new cost-cutting ideas, new and improved products, supplies and services. You can't afford to miss it.

Hundreds of important manufacturers will be represented with exhibits—showing you the latest in time, effort and money-saving methods for every phase of production. This is your chance to see and compare competing products on the spot. A single cost-saving idea . . . and there will be many for everyone who attends . . . will more than make the trip profitable to you and your company.

Write for free tickets today.

at the **1952**

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CLEVELAND *Public Auditorium*

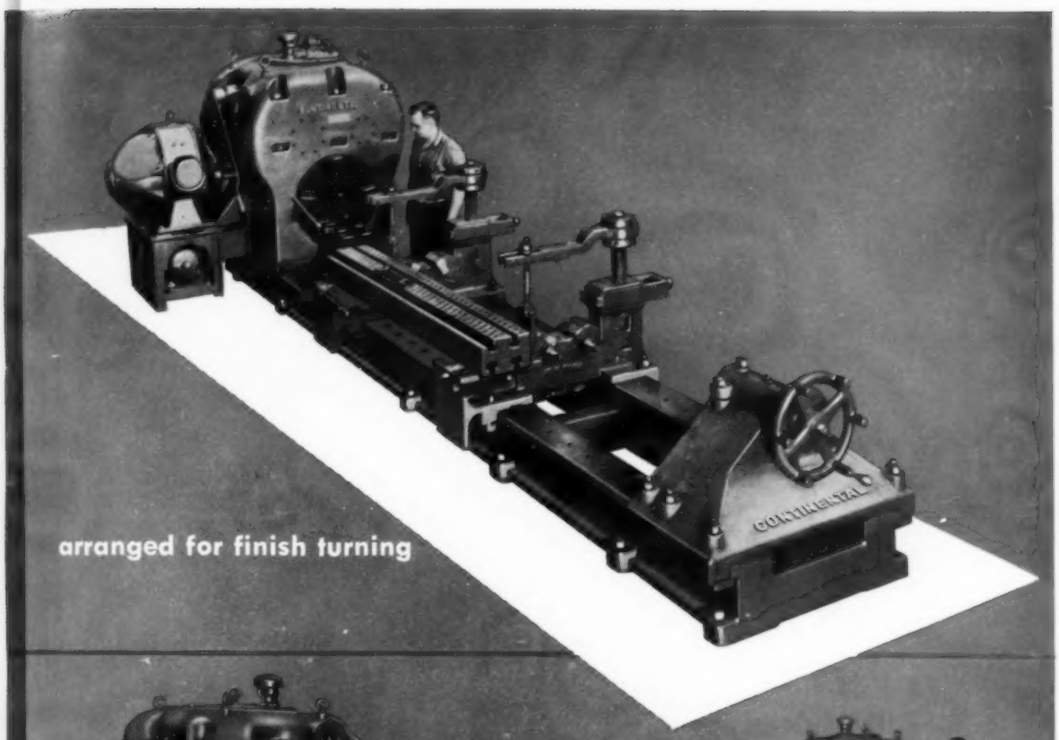
SEPT. 30, OCT. 1, 2 and 3

ASSOCIATION OF IRON AND STEEL ENGINEERS

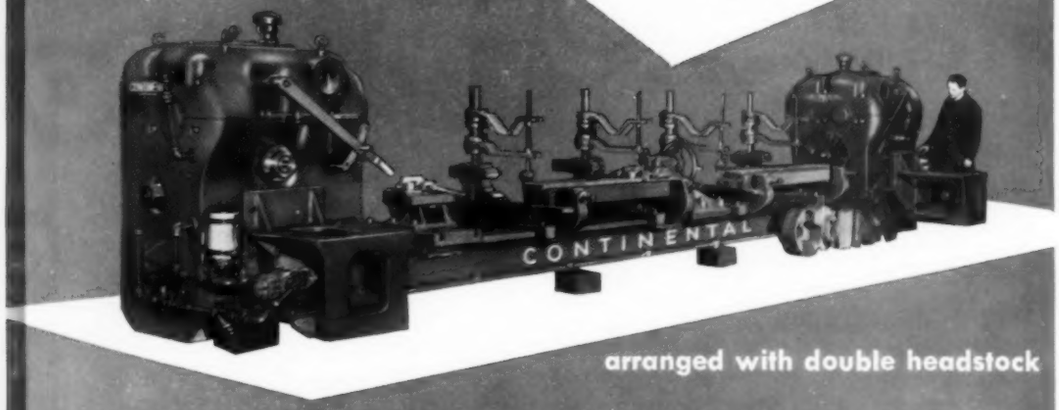
1010 EMPIRE BUILDING • PITTSBURGH 22, PA.

Continental

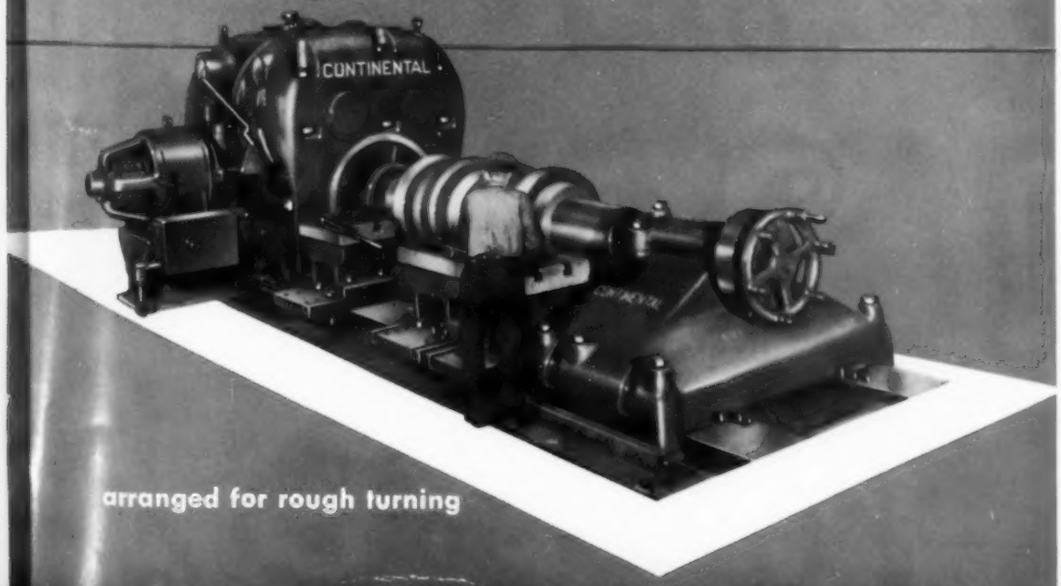
HEAVY-DUTY ROLL LATHES



arranged for finish turning



arranged with double headstock



arranged for rough turning

Rolling Mill installations engineered complete

for steel, alloy and non-ferrous metals

BLOOMING MILLS
STRUCTURAL MILLS
RAIL MILLS
BILLET MILLS
ROD MILLS
BAR MILLS
MERCHANT MILLS

★ ★ ★

SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

★ ★ ★

Mills complete with Auxiliary Equipment

★ ★ ★

ROLL LATHES

★ ★ ★

SPECIAL MACHINERY

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CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

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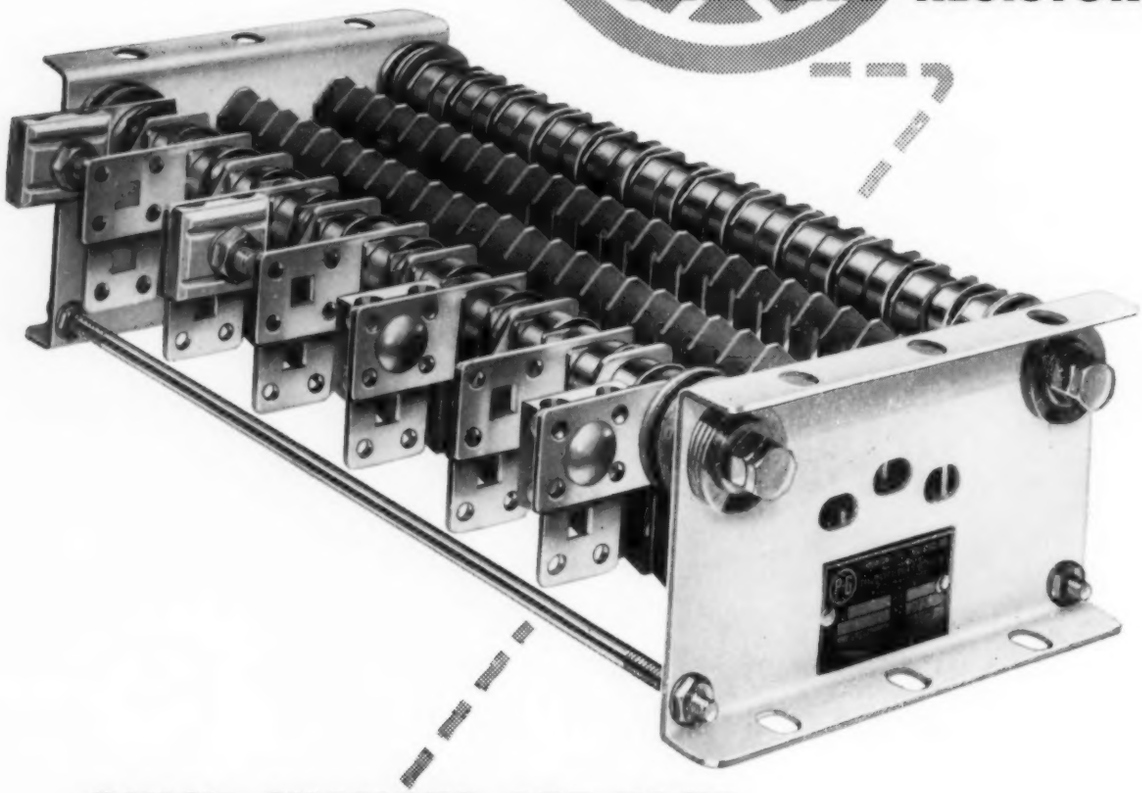
CONTINENTAL
Foundry & Machine Company

INDIVIDUAL RESISTOR REQUIREMENTS *Solved...*

with *Nonbreakable* P-G STEEL GRID RESISTORS!



QUICK CHANGES ARE EASY...

Little effort required to make adjustments.

- Minor variations often possible by wire change to other available terminals.
- Greater variations easily produced by movement of terminal position in the unit.
- Major variations effected by removal or addition of one or more standard banks.

For minimum maintenance and maximum production, specify P-G.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

Who has tried it?
Has it been successful?
What can new users expect?

PALMOSHIELD

Six months ago Palmoshield was introduced to readers of this magazine as the first workable replacement for imported palm oil in cold rolling operations. At that time we listed four advantages for the new lubricant.

1. Palmoshield is produced in the heart of the steel industry. Users are not dependent on overseas shipment.
2. Palmoshield is made from domestic materials so freely available as to supply all American steel production.
3. Palmoshield need not be stockpiled by the user, yet it does not deteriorate in storage.
4. Palmoshield is subject to exact chemical control. You can specify free fatty acid content to ½%—and get it.

The record of the past six months in various types of cold rolling operations have fully justified each of these claims.

Mill Use Establishes Two New Benefits

On the basis of orders delivered and actual mill experience, we feel Palmoshield now offers new users two additional advantages:

To Purchasing Agents. The price of Palmoshield is not artificially controlled. It rises and falls freely with the domestic fat market. In the past six months users have received five voluntary price cuts totaling 33%.

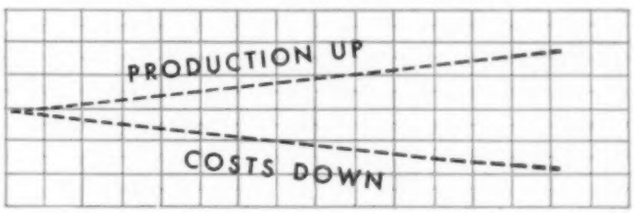
To Operators. Mill experience indicates that the use of Palmoshield improves production.

Palmoshield requires absolutely no changes in rolling mill operation.

Use of Palmoshield results in quicker to gauge in better shape.

Water break tests show that Palmoshield washes grease-free under conventional cleaning operations.

The result—increased tonnage at less cost.



Quick Acceptance by Major Steel Producers

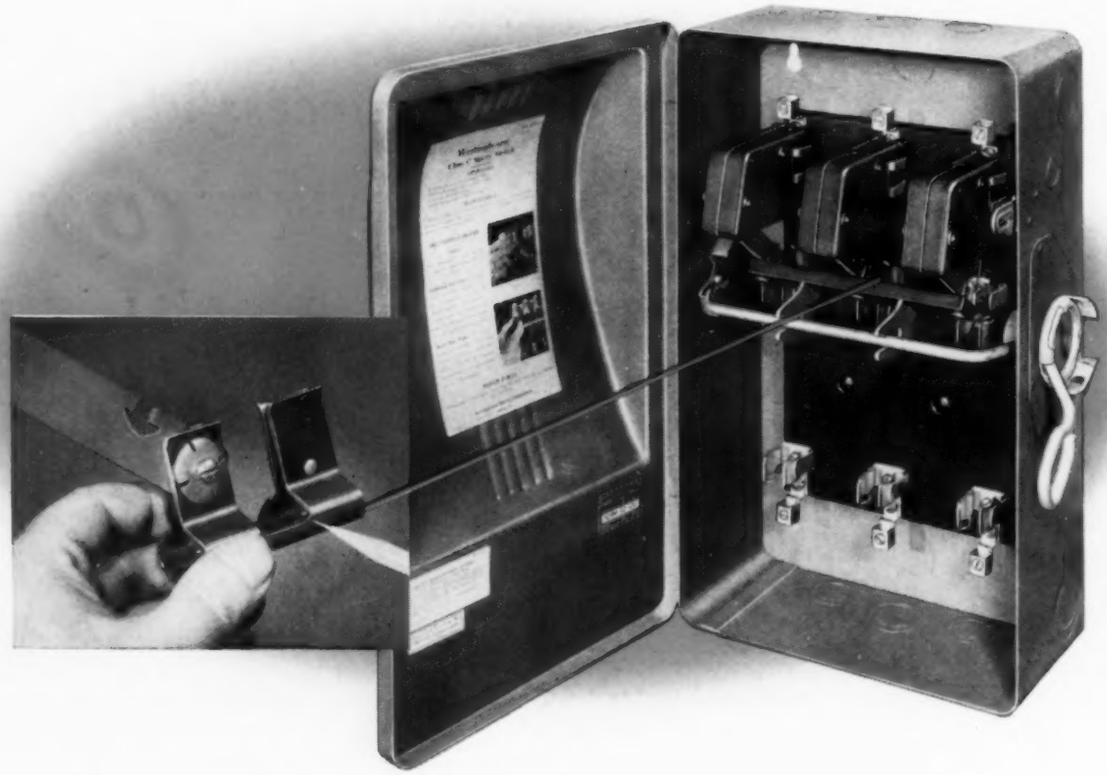
Public "name dropping" is not our policy. But we can state that nearly two-thirds of the major tin plate mills in this country and Canada are now using Palmoshield either in regular mill operation or for on-the-job test runs, and with uniformly satisfactory results. On request, an Ironsides representative will give you, in person, case-history facts on Palmoshield to help you decide whether to test this new lubricant in your mill.

Palmoshield is available for same-day shipment in 55-gallon drums and tank car lots. For details write The Ironsides Company, 270 West Mound St., Columbus, Ohio.

SPECIAL LUBRICANTS and PRESERVATIVES

IRONSIDES SHIELD PRODUCTS **PALMOSHIELD**

New *Life-Line* Safety Switch



Stands up...Stands out!

ONE-PIECE COPPER CONSTRUCTION

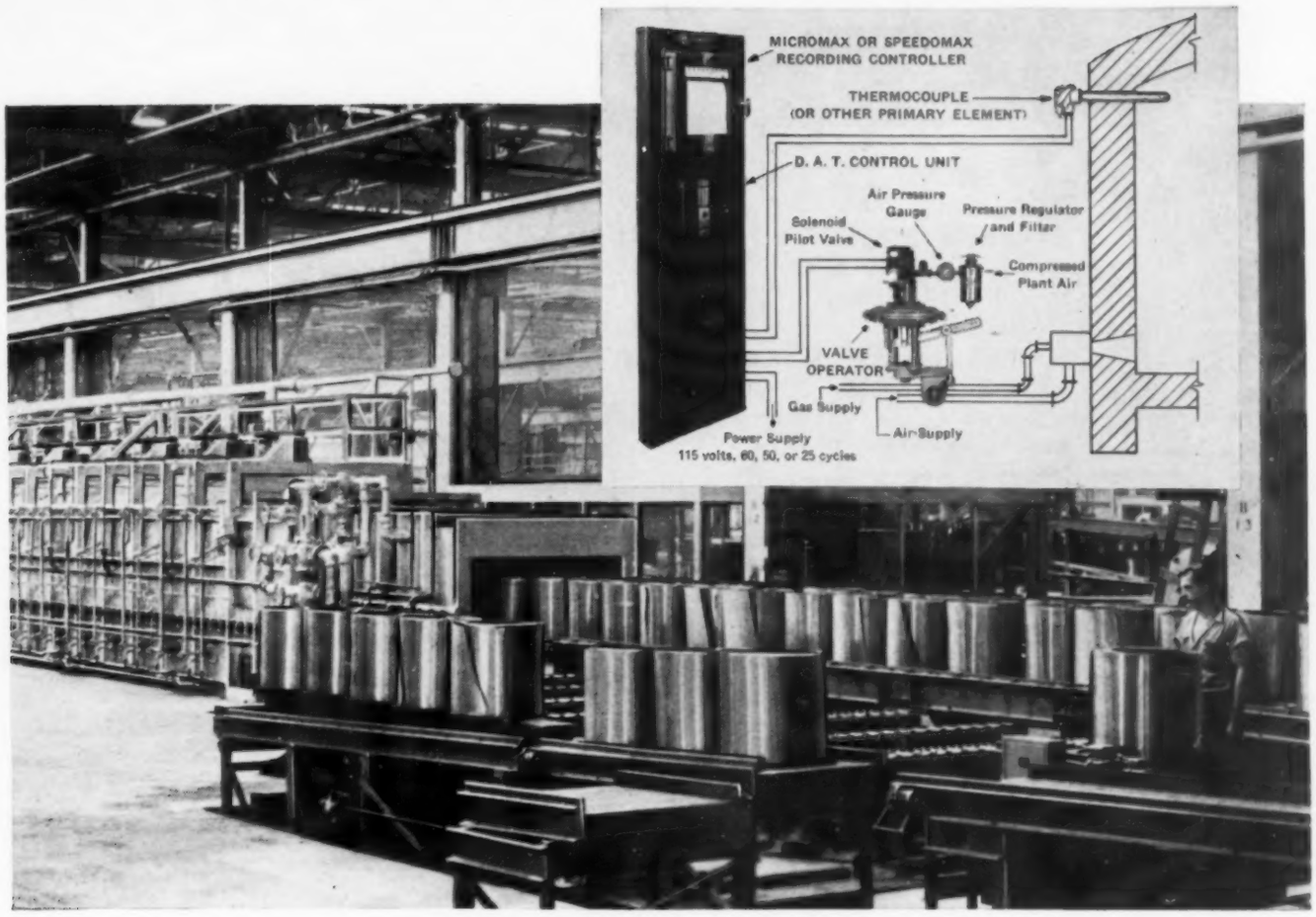
Shopping for switches? Then the new line of Westinghouse Life-Line Safety Switches are the tough, dependable performers you're looking for.

Mechanically and electrically, the parts that aren't there won't wear. One-piece copper construction of contact jaws, hinge jaws and terminals means 2 to 7 fewer joints per pole to loosen and wear, fewer points to oxidize and cause excessive internal heating, voltage drop, power loss. Yes, here's a big plus in safety switches that you can bank on for the long run in efficiency and economy.

An attractive Bonderized® finish protects the enclosure itself from corroding, chipping, blistering. Through and through, Westinghouse Life-Lines are built to withstand vibration, impact or other contingencies of heavy-duty application.

Certainly your best buy in safety switches today is the Westinghouse Life-Line Switch. Get in touch with your Westinghouse Distributor, or write for bulletin B-5457, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-30085

YOU CAN BE SURE... IF IT'S
Westinghouse
APPARATUS DISTRIBUTOR
Life-Line
SAFETY SWITCHES



THIS "package" OF CONTROL FITS ITSELF TO FURNACE NEEDS

. . . and only L&N can supply all its features!

• Scovill Manufacturing Company credits pyrometric control of their 119-foot annealing furnaces with a big part in helping to produce the most uniform, high-quality brass they've ever made. Each furnace anneals sheet in 2000 lb. coils and has a capacity of 32,500 lbs. per hour. The four furnaces were built by Surface Combustion Co. and The Electric Furnace Co. for Scovill's 10 million dollar continuous strip mill.

Scovill's success in controlling temperatures is timely because it shows what can be done with thousands of other industrial furnaces. Small units may need only one instrument, instead of Scovill's five per furnace.

But the principle is the same.

Instead of arbitrarily turning fuel "on" at a predetermined low temperature, and "off" at a predetermined high, D.A.T. alternately turns heat on and off—flexibly adapting the periods of on-time to the needs of the furnace. When temperature begins to rise above the set-point, the periods of on-time become shorter. When temperature falls, periods of on-time grow longer. In this way, D.A.T. exactly adapts its action to the upsets, load changes and lags of the furnace. This means it holds temperature in line for all normal changes in furnace charge, ambient temperature, temperature control point, etc.

Increased production resulting from unusual uniformity is the great advantage of D.A.T. but other points are worth remembering:

Fuel can often be saved because less heat is lost up the stack.

Valve and burner sizes are not particularly critical.

D.A.T. can often modernize an old furnace, because it's so easy to install.

D.A.T. operates equally well on furnaces of full-muffle, semi-muffle, open firing and conventional radiant-tube design.

D.A.T. is just one of several L&N Controls. Call us for service or information in selecting equipment for any temperature-control problem. Address nearest office or 4942 Stenton Ave., Philadelphia 44, Penna.

LEEDS & NORTHRUP

instruments • automatic controls • furnaces

Jrl. Ad N-33A-626(7)

What do you want in a drive

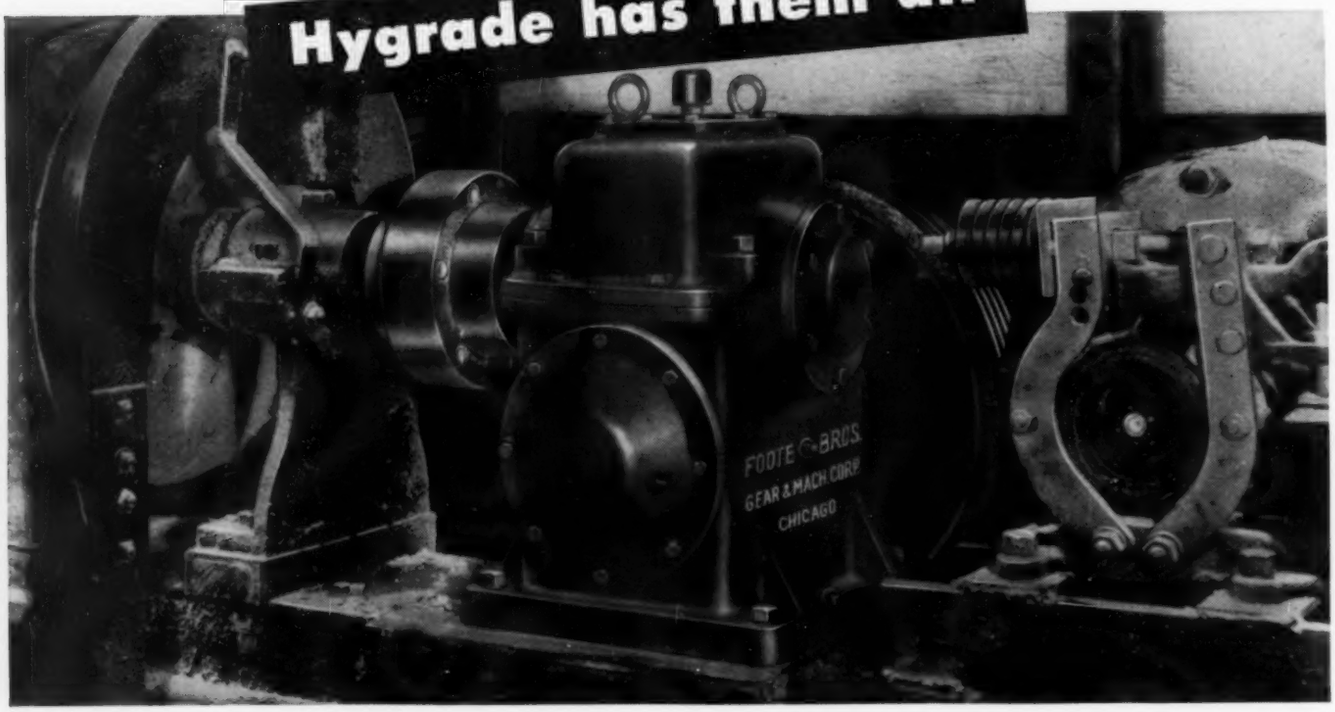
RUGGED STRENGTH

TROUBLE-FREE OPERATION

COMPACTNESS • ECONOMY

PRECISION ENGINEERING

Hygrade has them all



Engineered for those tough jobs in your plant where heavy duty demands rugged strength — ideal for any job where reliability, compactness, economy in operation are desired.

Foote Bros. Hygrade Drives are available in horizontal and vertical designs in a wide range of ratios up to 4108 to 1 — higher when required.

Hygrade Hytop Drives have wider, low-speed bearing span to accommodate long, unsupported vertical output shaft extensions, either upward, downward, or both. Advanced engineering, improved design, new techniques in manufacture, better control of material all make Foote Bros. Hygrade Drives ideal for your plant. Mail the coupon for Bulletin HGB.

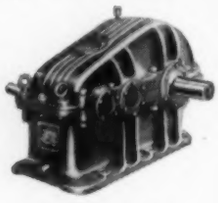
FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Line-O-Power Drives

Foote Bros.-Louis Allis Gearmotors



Maxi-Power Drives

FOOTE BROS. HYGRADE DRIVE
Installed on the manlift in International Milling Co. Plant at Detroit, Michigan.

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 S. Western Boulevard
Chicago 9, Illinois
Please send me a copy of Bulletin HGB on Foote Bros. Hygrade Drives.

Name.....

Company.....

Address.....

Position.....

City.....State.....

FROM THE TOP STEEL PRODUCER . . .

TO A LEADING CHEMICAL HOUSE,

A YEAST COMPANY

AND A MEAT PACKER . . .

Heat Prover SERVES 62 DIFFERENT COMPANIES IN THE GREAT CHICAGO INDUSTRIAL AREA!

The Cities Service Heat Prover is graphically proving its worth to all kinds of industry in the Chicago area and elsewhere throughout the country.

62 different companies, producing everything from steel to beef, have found the Heat Prover an important aid to increased production and big dollar economy.

WHEREVER A FURNACE OPERATION IS INVOLVED, Heat Prover can help increase productivity by providing:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

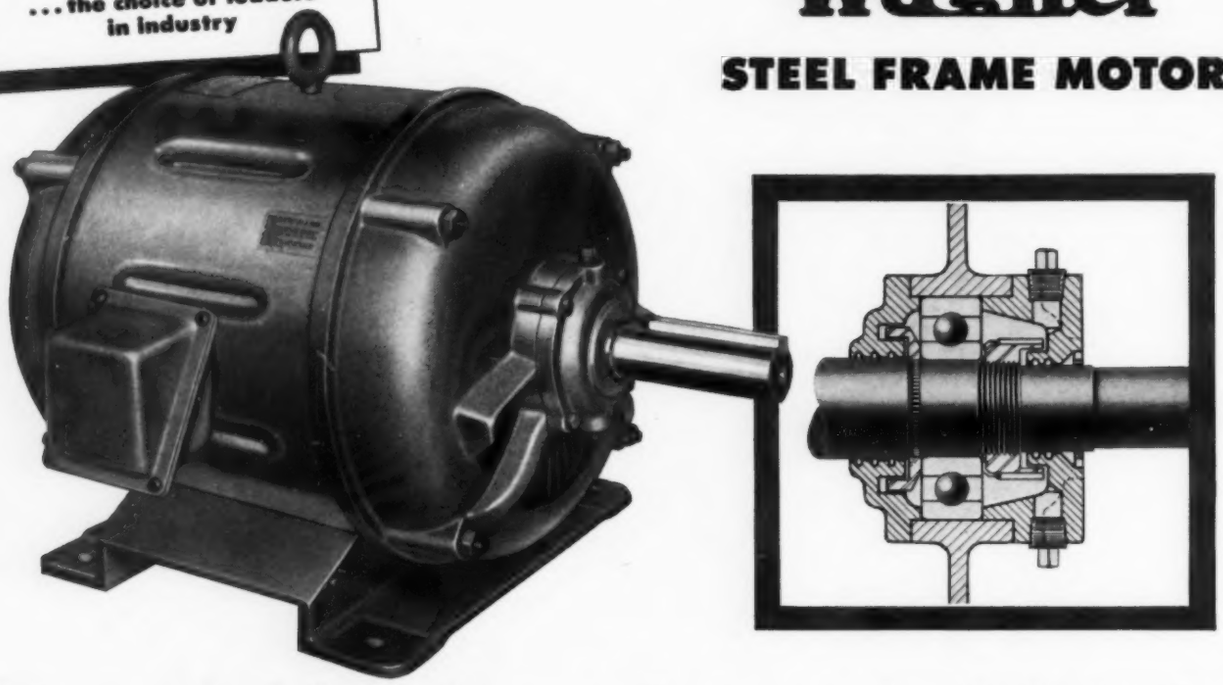
REMEMBER: Heat Prover is not an instrument you buy but a service we supply. Contact the Cities Service office in your area and learn how Heat Prover can serve you . . . or write CITIES SERVICE OIL COMPANY, Dept. G17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Wagner
ELECTRIC MOTORS
... the choice of leaders in industry

Wagner
STEEL FRAME MOTORS



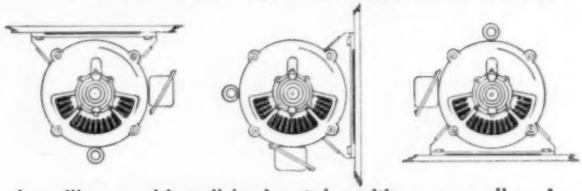
This sealed-bearing motor can be lubricated

Wagner Steel-Frame general purpose polyphase motors are equipped with labyrinth sealed bearing housings that effectively prevent the entrance of any dirt or grit that might cause premature wear. It is not necessary to lubricate the bearings—motors in the smaller frame sizes operate for years without relubrication. But... these Wagner Motors are provided with two lubrication openings — you *can* lubricate your motors when necessary or desirable, to add years of useful motor life in unusually severe applications.

Wagner's Bulletin MU-131 gives valuable information concerning proper lubrication of electric motors — Copies will be sent you on request.

DRIP-PROOF... 3 WAYS

These open-type motors (in frames 326 and smaller) are completely drip-proof in any horizontal position because there are no openings in the frame and the end-plates can be rotated 90° or 180° for drip-proof installation



in ceiling or sidewall horizontal positions, as well as in the normal horizontal position.

Wagner Steel-Frame Motors are available in electrical types to meet most industrial requirements. Bulletin MU-185 gives full information—write for your copy.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

®Wagner Electric Corporation EST. WE 1891

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

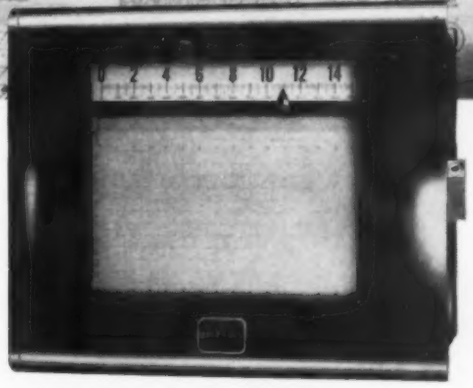
BRANCHES IN 32 PRINCIPAL CITIES

B52-17

Instrument Makers CHECKED ✓

and chose the BRISTOL DYNAMASTER

Continuous-balancing electronic recorder



The instrument makers whose advertisements appear above know that their reputations depend upon the accuracy and reliability of their recorders. They select each component part with scrupulous care.

As the recording unit in their instruments, they all selected Bristol's Dynamaster. When you choose the Dynamaster for your own measuring needs you are assured of the same accurate, precise instrumentation demanded by these instrument makers.

THERE'S A DYNAMASTER FOR EVERY NEED

Available as a bridge or potentiometer, with strip or circular charts, Dynamasters can measure any variable that can be converted into changes in d-c voltage, d-c current, resistance, or capacitance.

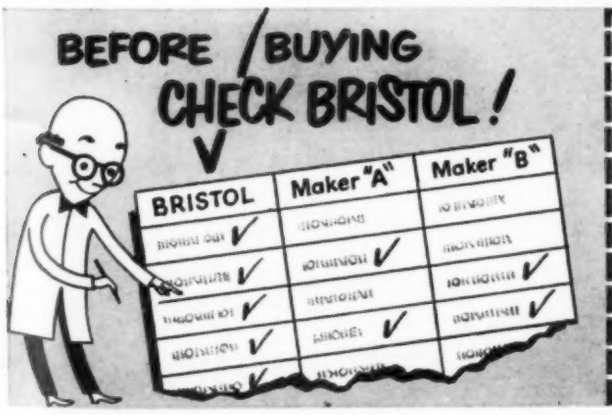
Dynamasters are providing accurate, trouble-free measurement and automatic control of such quantities as temperature, pressure, pH, speed, voltage, power, current, smoke density, strain, and resistance.

BRISTOL

FOR MORE INFORMATION *on the uses of this versatile recorder, use the coupon to get Catalog No. P1245.*

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



THE BRISTOL COMPANY
123 Bristol Road
Waterbury 20, Conn.

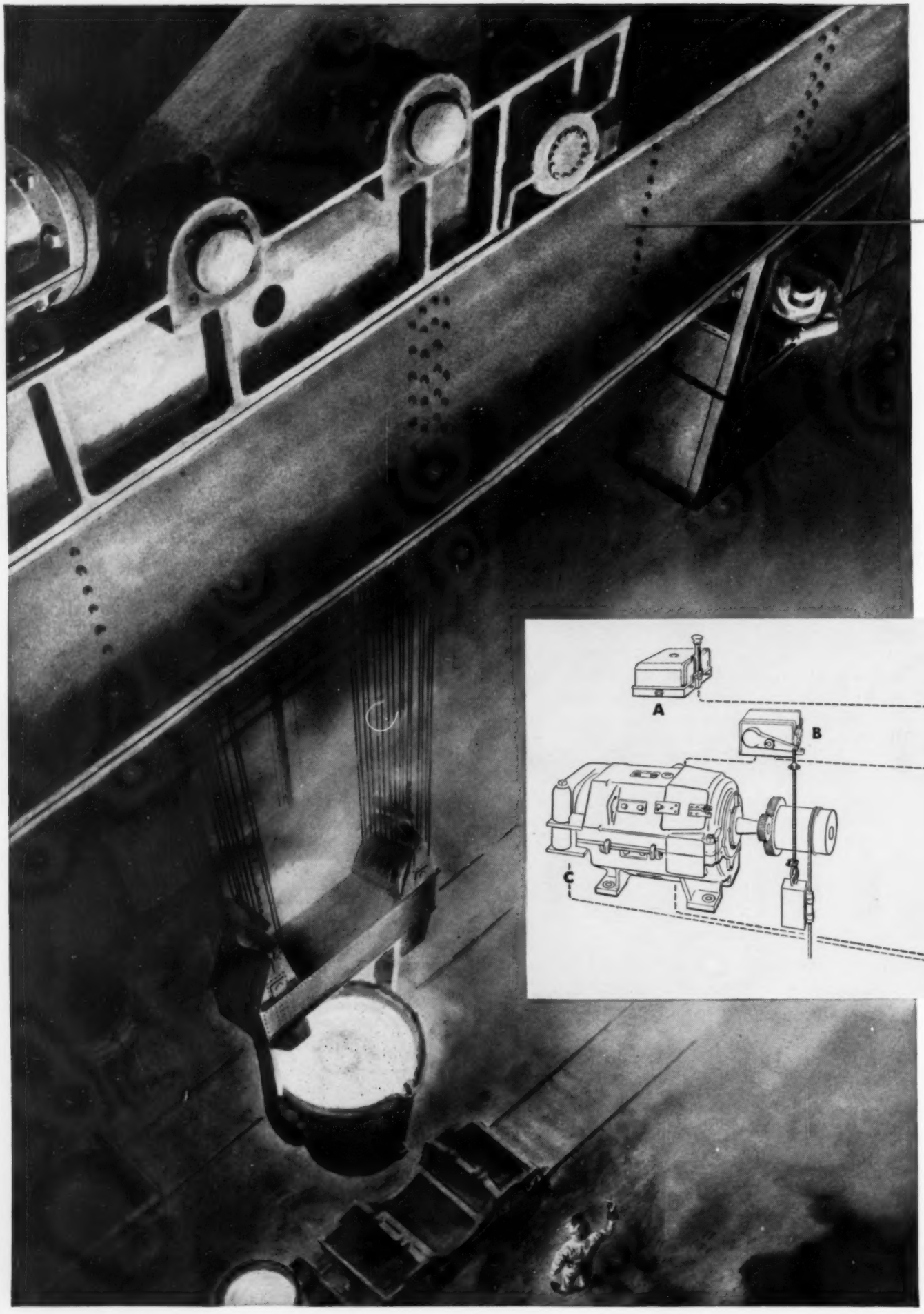
Please send catalog giving details of Dynamaster performance to:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

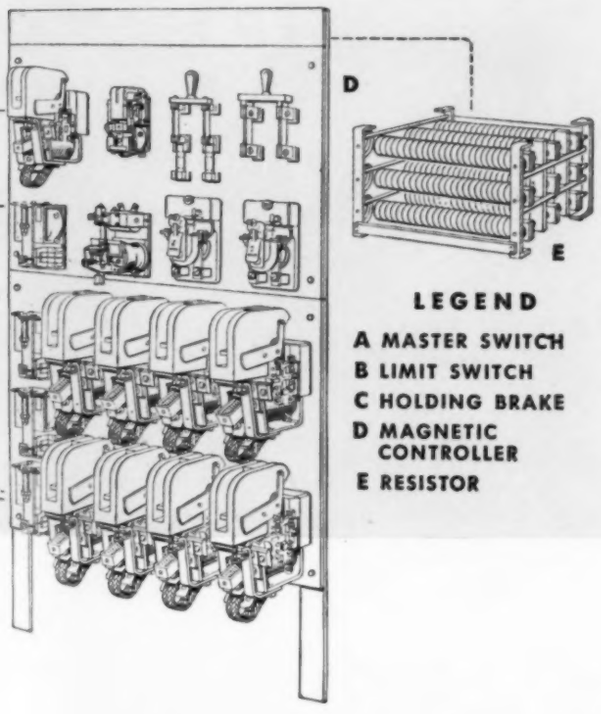
CITY _____ ZONE _____ STATE _____


A
B
C

MILL RATED muscle for heavy hoisting

Steel mill crane hoist control must have the stamina to take ceaseless beatings. It must be built of components that are mill rated . . . that keep functioning regardless of exposure to dust, dirt, heat, cold and round-the-clock hard service.

The Westinghouse D-C Constant Voltage Crane Hoist Control meets these requirements. It is built to stand up to the daily abuse found in most steel mill operations. Heavy-duty, mill-type electrical equipment is used throughout. The Type M contactors and series-wound, 600-series, d-c motor are mill rated. Dependable operation is further assured by the basic simplicity of the control system.



OPERATING CHARACTERISTICS ARE COMPLETE AND FLEXIBLE

Loads Slip Into Place due to proper proportioning of speed increments between master switch points and selection of correct resistor connections.

Slow-Speed Hoisting Is Available with empty hook. In lowering, suitable kickoff torque is obtained with careful resistor design enabling the motor to reach steady-state speed quickly without overshoot.

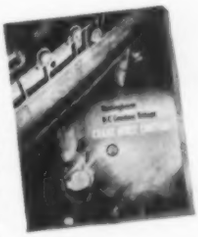
High Lowering Speeds Are Available when required. The high-speed lowering point has an independent adjustment to facilitate closer control at these high speeds.

Standard Control Panel contains only nine contactors and four timing relays in addition to protective equipment. All are front mounted for easy accessibility. All are standard units.

New Heavy-Duty Contactors and a combined control system and resistor design, that prevent excessive current peaks during transitions or while plugging, prolong equipment life.

Get this Descriptive Booklet B-5420

Full descriptive information on all components of the Westinghouse D-C Constant Voltage Crane Hoist Control is contained in this free booklet. Your Westinghouse representative has a copy for you. Or, you can get a copy by writing direct to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27017



YOU CAN BE SURE...IF IT'S Westinghouse

CRANE CONTROLS

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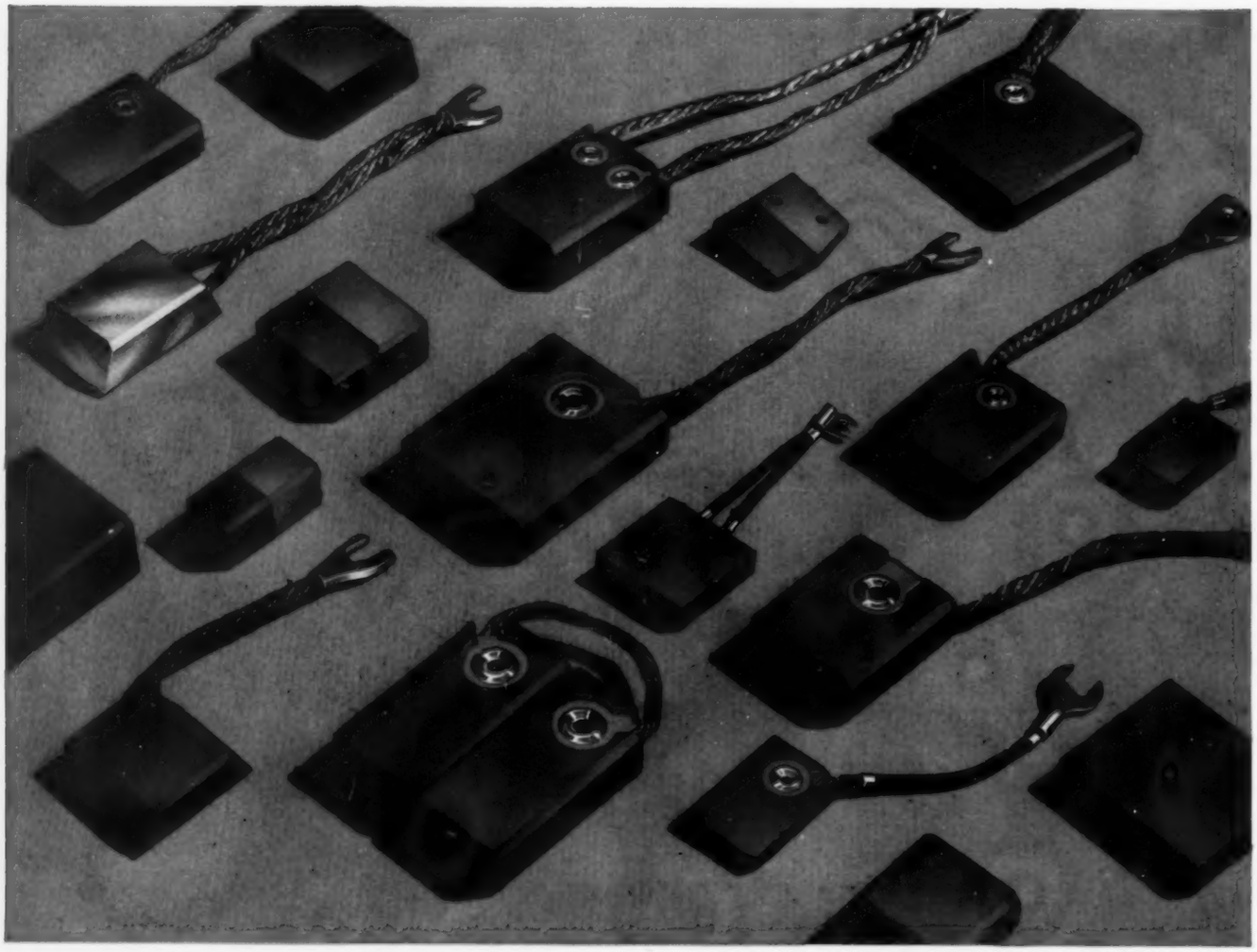
BUY USG® BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

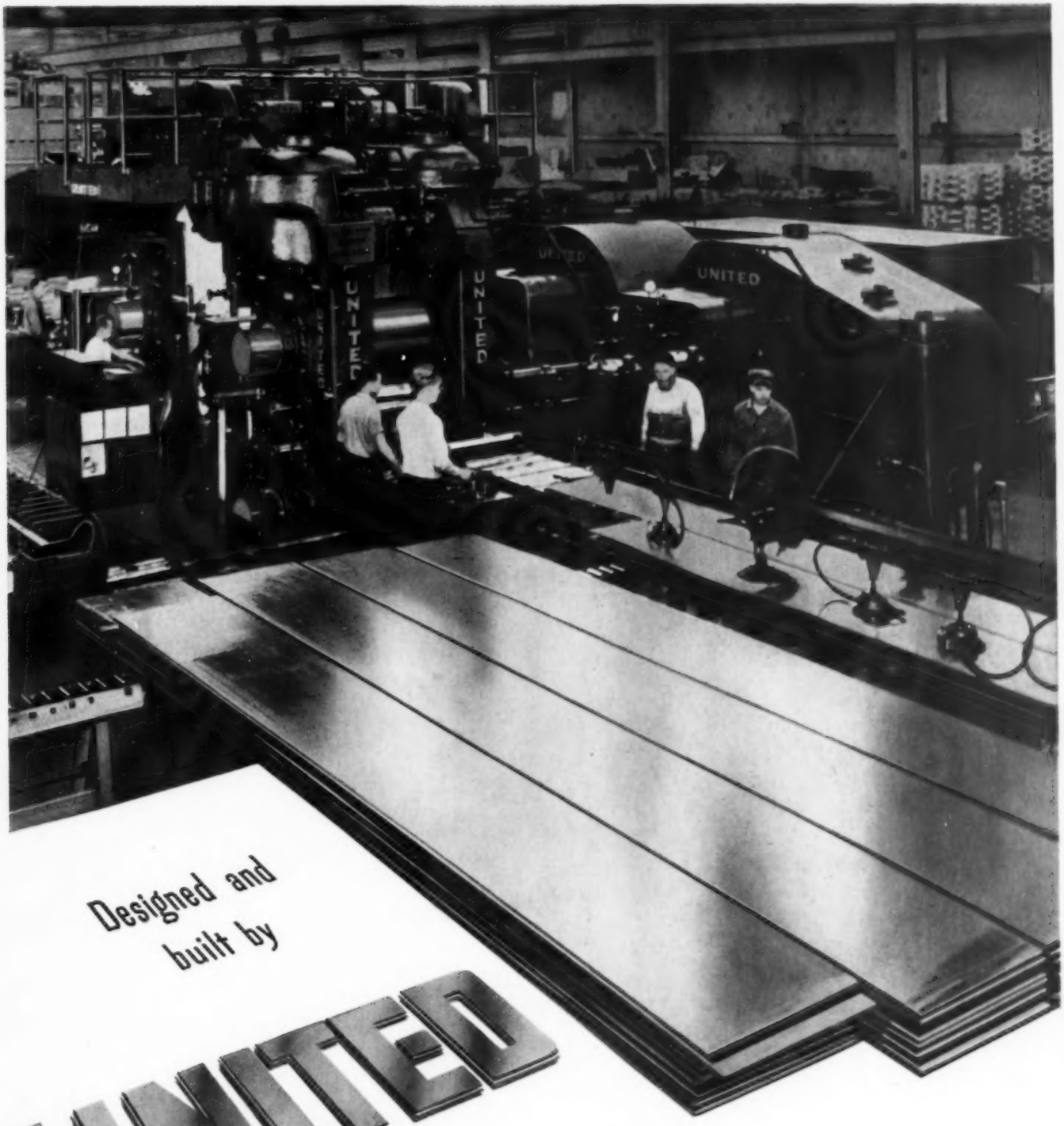
Write today for 40-page catalog giving complete information on standard USG grades.



90-B

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



Designed and built by

UNITED

4-HIGH 2-STAND TANDEM BRASS MILL

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

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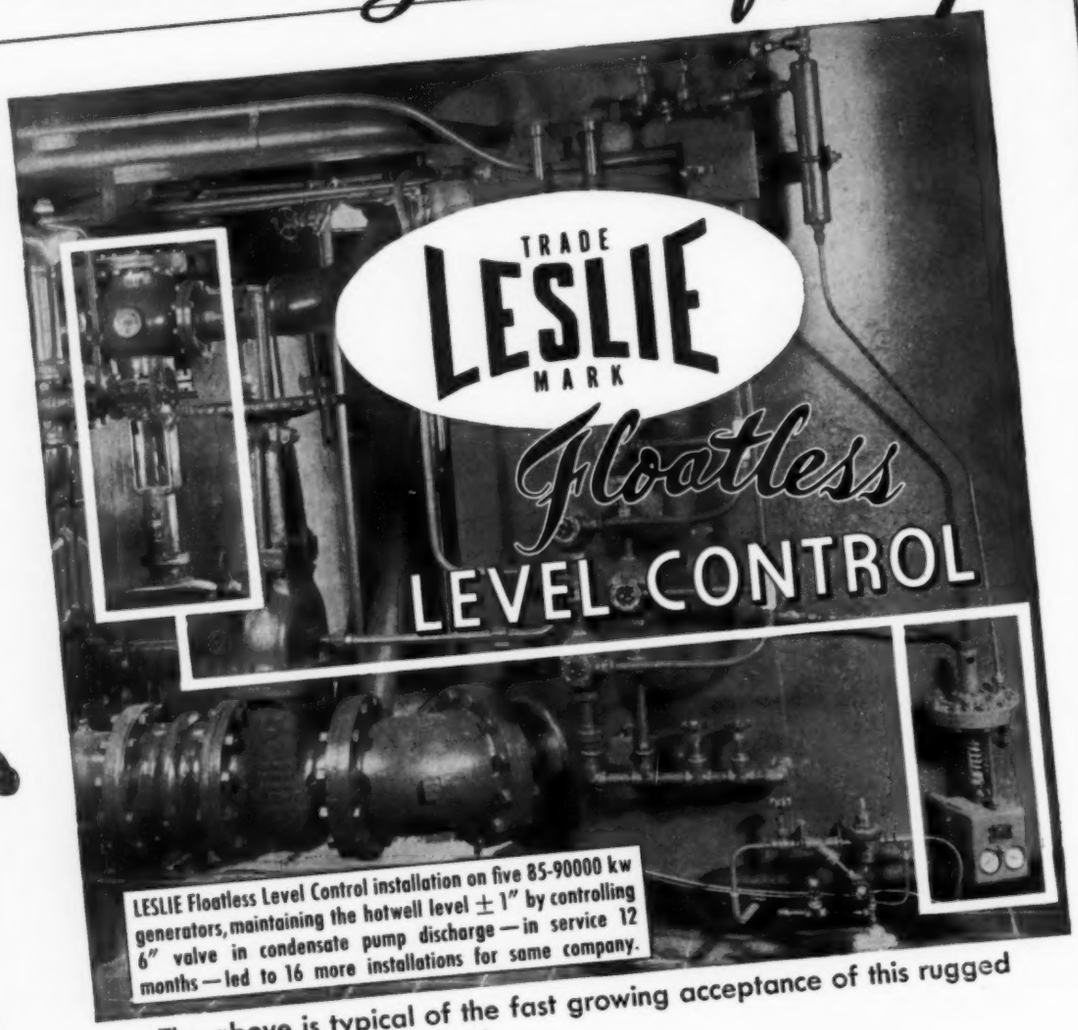
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

An Outstanding Record of Acceptance!



LESLIE Floatless Level Control installation on five 85-90000 kw generators, maintaining the hotwell level ±1" by controlling 6" valve in condensate pump discharge — in service 12 months — led to 16 more installations for same company.

The above is typical of the fast growing acceptance of this rugged and accurate level control.

ADVANTAGES

- **EASY TO INSTALL**
- **ACCURATE REGULATION (±1" Water Column)**
- **NO FLOATS, STUFFING BOXES, ETC.**
- **MULTI-MEDIUM ACTUATED**
- **DIAPHRAGM PRESSURE ELEMENT**
- **ACTION REVERSIBLE**

Applications: On open and pressurized vessels, including boilers, tanks, evaporators, heaters, standpipes, etc.

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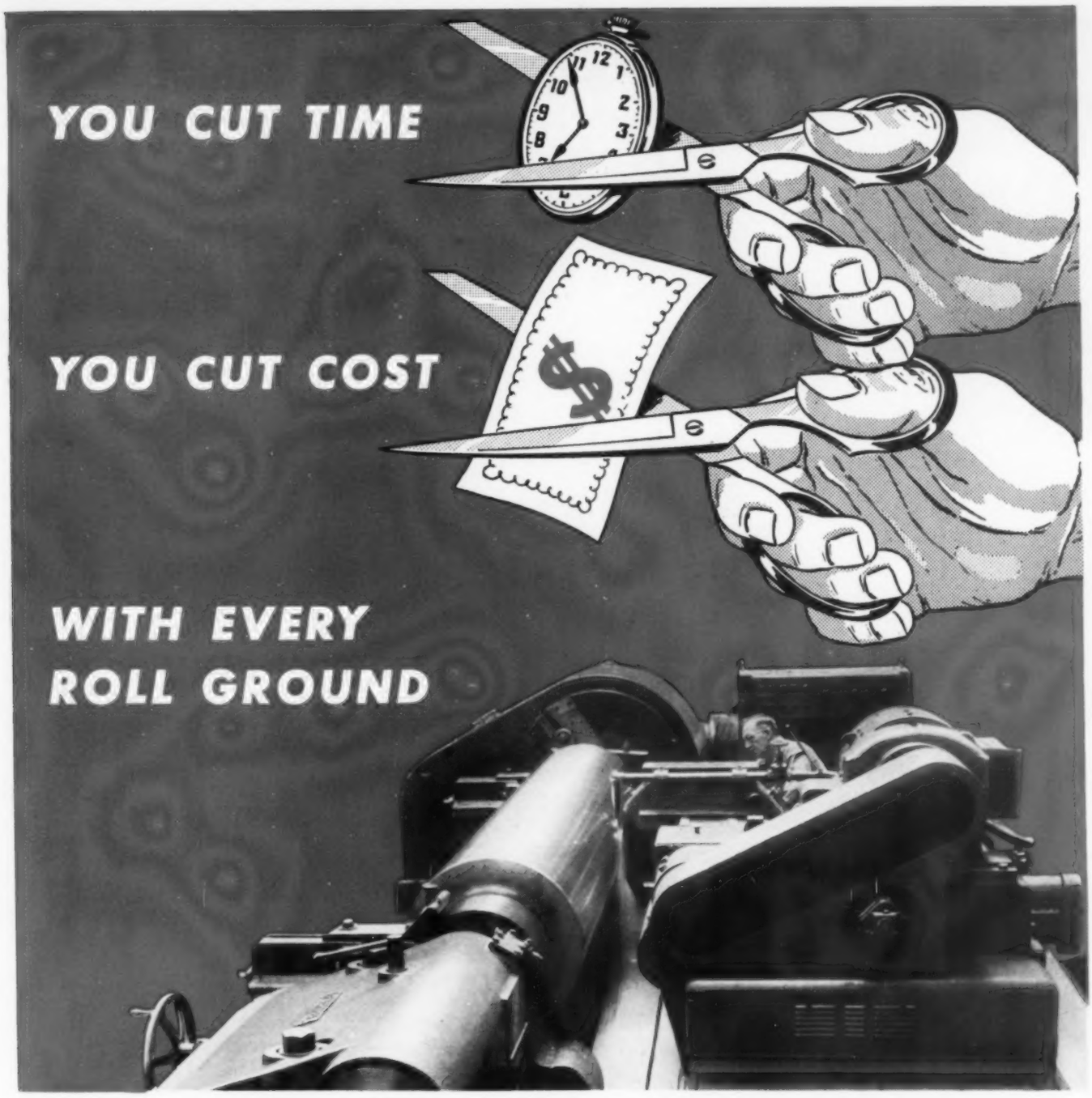
***SEND for* illustrated Bulletin**

Look for LESLIE Regulators under "Valves" or "Regulators" in your Classified Telephone Directory in leading industrial cities where LESLIE factory-trained engineers are located.

LESLIE CO., 247 Grant Avenue, Lyndhurst, New Jersey

1627

PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS • FLOATLESS LEVEL CONTROLS
PUMP GOVERNORS • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • AIR HORNS • STEAM WHISTLES



ON A FARREL MACHINE

Users of the latest type Farrel roll grinders find the machine extremely fast for either heavy roughing or producing as high a mirror finish as it is possible to obtain with wheels at present available. Many automatic features simplify both set-up and operation. Setting-up time is held to a minimum.

Faster grinding means less labor per roll ground, which cuts the cost of grinding. Furthermore, because of the exceptionally smooth and vibration-free action in roll, wheel and traverse drives, less metal has to be removed to clean up a roll in roughing and finishing operations. This reduces the frequency of roll replacement and, consequently, the cost of new rolls.

Send for further information about these time-saving, cost-cutting roll grinders. They are available in two types—type HD shown here, and type TT with traveling work table. Bulletins giving complete specifications of either type will be sent promptly on request.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

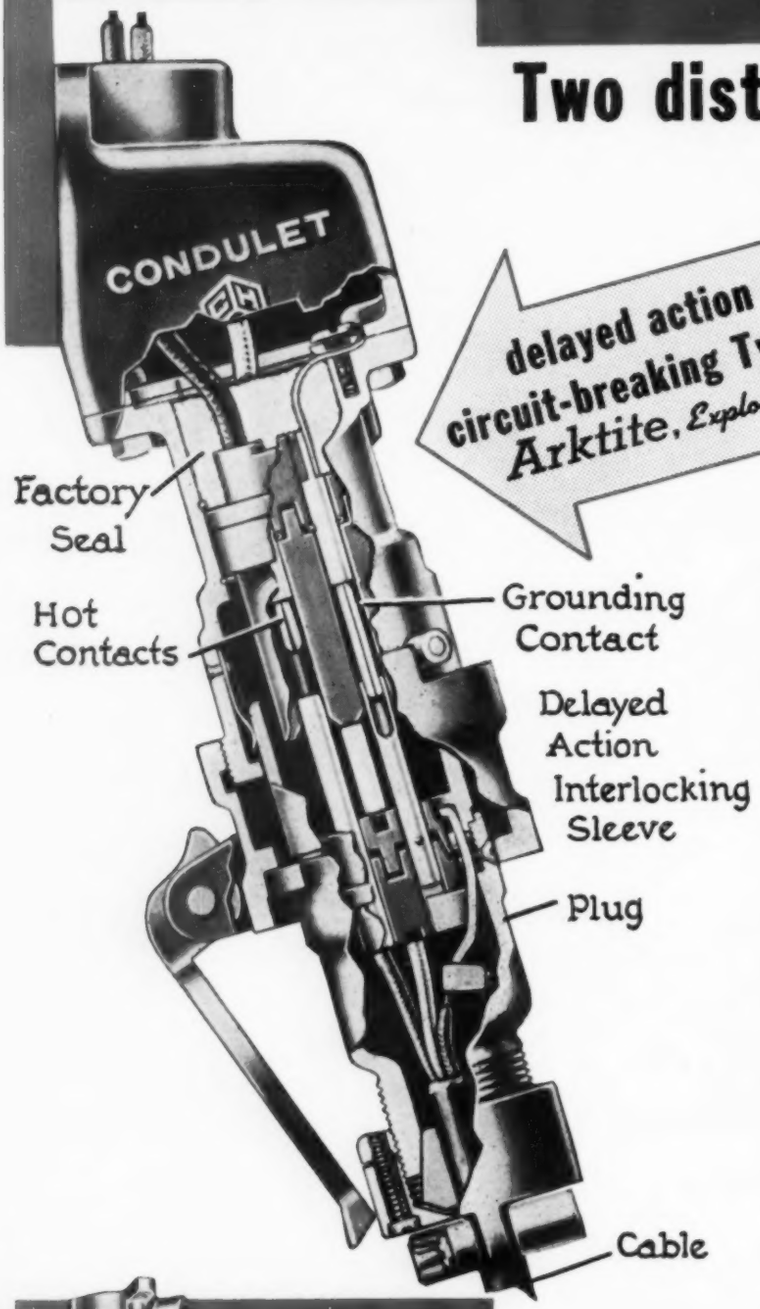
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

FB-748

Farrel-Birmingham®

CROUSE-HINDS PLUGS and

Two distinct types in a wide hazardous area



delayed action and circuit-breaking Type CES Arktite, *Explosion-Proof*

Both types have been service tested through the years for continued safe and dependable use. Both are approved by Underwriters' Laboratories, Inc. . . . Type CES for atmospheres containing explosive gases or vapors and Type FSQ for either explosive or dusty atmospheres. You can rely on both types for the safe connection of portable electrical equipment in such hazardous locations.

Type CES

1. Crouse-Hinds famous *Arktite* design . . . circuit-breaking at full load . . . no disconnect switch required.

2. Plugs can be used in non-explosion-proof *Arktite* receptacles, permitting the use of special explosion-proof portable equipment and tools in non-hazardous locations. However, non-hazardous equipment cannot be used in hazardous areas because Type CES Explosion-Proof Receptacles will not accept the regular *Arktite* plugs.

3. Simple delayed action feature . . . insert plug, twist . . . push. Contacts make and break in tight explosion-proof chamber without enough oxygen to maintain the arc.

4. Pigtails in splice box . . . factory sealed to contain any explosion.

5. Up to 30-Amp., 460-Volt, A. C.; 60-Amp., 230-Volt, A. C., single and 3-phase.

6. Explosion-proof.

Type CPS 15-Ampere | Type CPS 15-Ampere | Type EHS Flush Mounted Up to 30-Ampere | Type CPS Flush Mounted Up to 30-Ampere

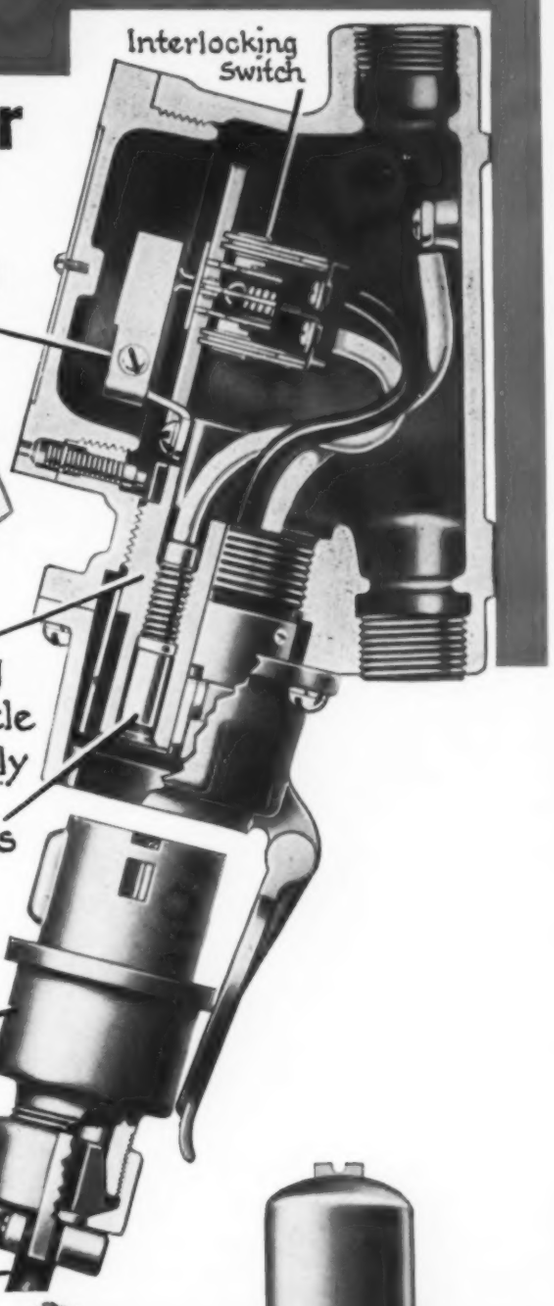
← **Other explosion-proof *Arktite* receptacles similar to CES.**

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS • TRAFFIC SIGNALS

Explosion-Proof and Dust-Tight RECEPTACLES

range of sizes to meet your requirements



interlocked switch Type FSQ
Explosion-Proof, Dust-Tight

Type FSQ

1. Has built-in interlocked disconnect switch . . . no separate disconnect required.

2. Simple, sure dead front action . . . insert plug and twist to turn on switch . . . twist to withdraw plug. Twisting operates built-in switch. Plugs cannot be inserted or withdrawn with switch "ON".

3. The threaded cover can only be removed when the switch is "OFF" and the switch cannot be turned "ON" until the cover is on and locked in position by a special screw.

4. Up to 30-Amp., 460-Volt, A. C. single and 3-phase; or 250-Volt, D. C.

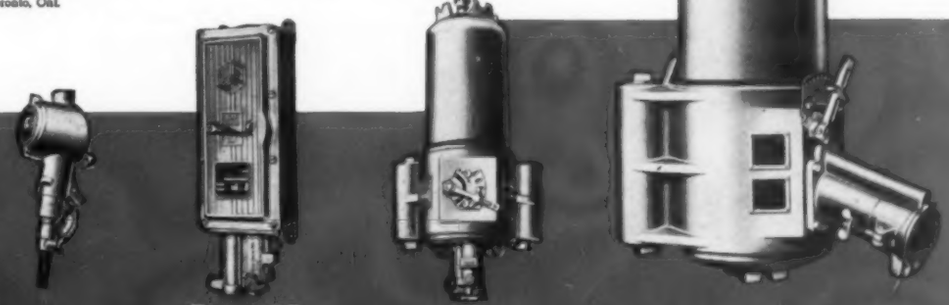
5. Explosion-proof and dust-tight.

Look for the complete listings in your Condulet Catalog, or send for full information.

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Albuquerque—Birmingham—Boston—Buffalo—Chicago—Cincinnati—Cleveland Dallas—Denver—Detroit—Houston—Indianapolis—Kansas City—Los Angeles—Milwaukee Minneapolis—New York—Philadelphia—Pittsburgh—Portland, Ore.—San Francisco Seattle—St. Louis—Washington. RESIDENT REPRESENTATIVES: Albany Atlanta—Baltimore—Charlotte—New Orleans—Richmond, Va. Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

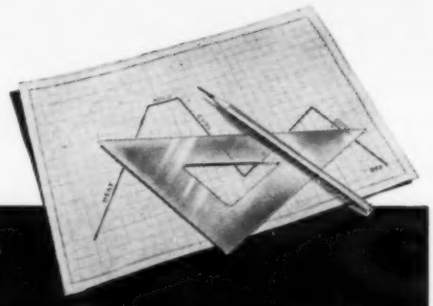
Other explosion-proof and dust-tight receptacles with interlocked switches or circuit breakers. →



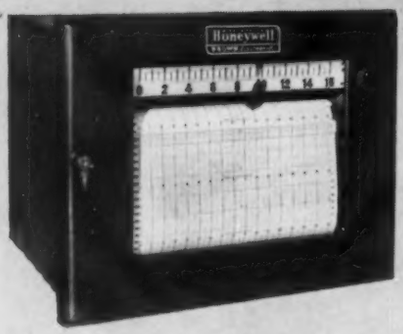
Type FSQ 10-Ampere | Type DBR Up to 100-Ampere (Dust-Tight Only) | Type EPC Up to 100-Ampere | Type EPC Up to 200-Ampere

AIRPORT LIGHTING • FLOODLIGHTS

Plan Time *vs* Temperature

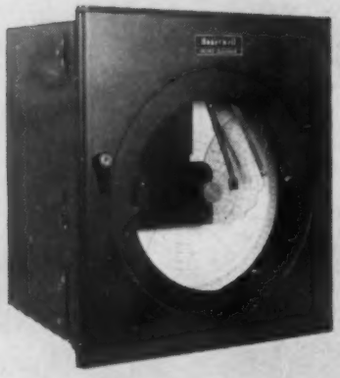


any way you like . . . with NEW *ElectroniK* Program Control



BROWN PROGRAM CONTROLLER WITH MOTOR DRIVEN INDEX

. . . the peak in flexibility, providing an infinite variety of programs. Heating or cooling rates are calibrated in degrees/hour, soaking time in hours or minutes . . . both are easily set. Three front-of-instrument temperature settings are available at which heating rate can change or soaking begin. Automatic change from heating to artificial cooling can be provided. Multi-zone control is also available.



BROWN CAM-OPERATED PROGRAM CONTROLLER

. . . for frequently repeated cycles. Cam is easily cut to desired time-pattern on calibrated disc of clear plastic. Nonlinear rise or fall is readily produced. Any number of heating, cooling and holding periods can be incorporated. Entire program is readily apparent, and can be duplicated at any time. Program change requires only the replacement of the cam.

Now, *ElectroniK* Program Controllers offer you a free hand in securing automatic regulation of time-temperature cycles. The way these controllers conduct furnaces through complete heating, cooling and soaking periods . . . signalling operators when critical points are reached . . . shutting off equipment at the end of the cycle . . . makes them exceed human abilities.

ElectroniK Program Controllers are designed for complete systems. Available with all varieties of electric and pneumatic control forms (including time or position-proportioning control). For a discussion of how this new, advanced control can improve your production, call in our local engineering representative . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

● *Important Reference Data*

WRITE FOR LITERATURE ON BROWN PROGRAM CONTROLLER WITH MOTOR DRIVEN INDEX AND ON BROWN CAM-OPERATED PROGRAM CONTROLLER

Job Engineered To Do A Better Job

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GLASTIC INSULATOR

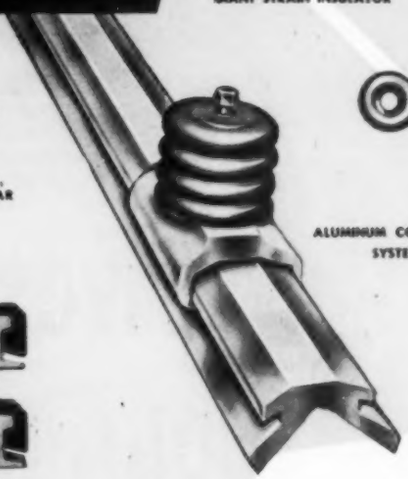
PORCELAIN INSULATOR

PORCELAIN INSULATOR

GIANT STRAIN INSULATOR

INSULATED EYE BOLT

TROLLEY WIRE EAR


ALUMINUM CONDUCTOR SYSTEM

TROLLEY WIRE SUSPENSION

CABLE STRAIN CLAMP

SUPPORTING STANDARD

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ANGLE CONDUCTOR SUPPORT

CABLE RACK

46 YEARS OF ESM EXPERIENCE BEHIND THESE COMPLETE INDUSTRIAL LINES

In current collectors, porcelain insulators, molded insulators, aluminum conductors, conductor supports, and cable accessories, Electric Service engineers have designed each unit for its particular job . . . each to provide peak efficiency. Progressive thinking . . . plus almost a half century of manufacturing experience assures you of products unsurpassed in design efficiency and long service. ESM engineers are ready, willing and able to help you with routine or special problems . . . call on them soon.

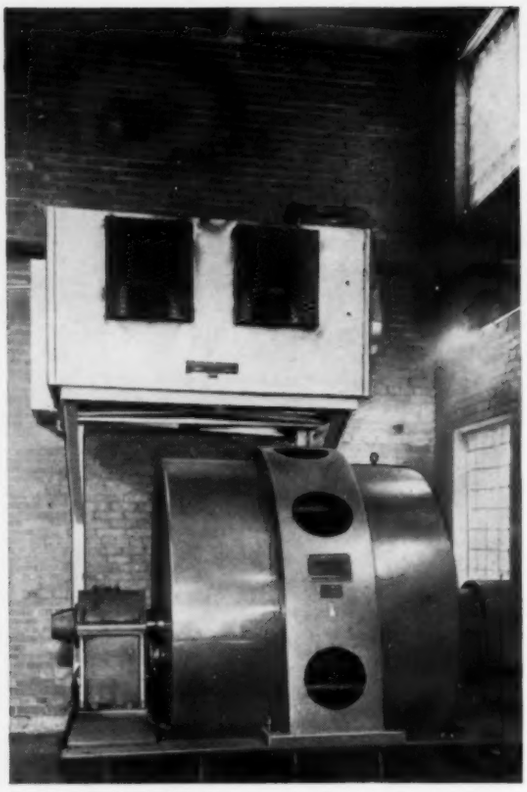
ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

Represented in Canada by Lyman Tube and Bearing, Ltd., Montreal and Toronto

Manufacturers of complete line of insulator supports for rail and wire conductors and current collection devices.

Continuous sintering in this plant begins with storage bins, each holding a different material. Feeders discharging from bins to conveyor are group-driven by co-ordinated G-E 5-hp adjustable-speed d-c motors, which keep individual feeders in correct speed relationship, assure uniform mixture at all times regardless of line's speed.



After actual mixing in two pug mills, mixture goes to sintering machine. This G-E 1000-hp synchronous motor drives sintering fan which draws air over charge. Fan, located outside building, is connected through wall at right.

G-E sintering-line drives maintain uniform mixture, continuous flow!

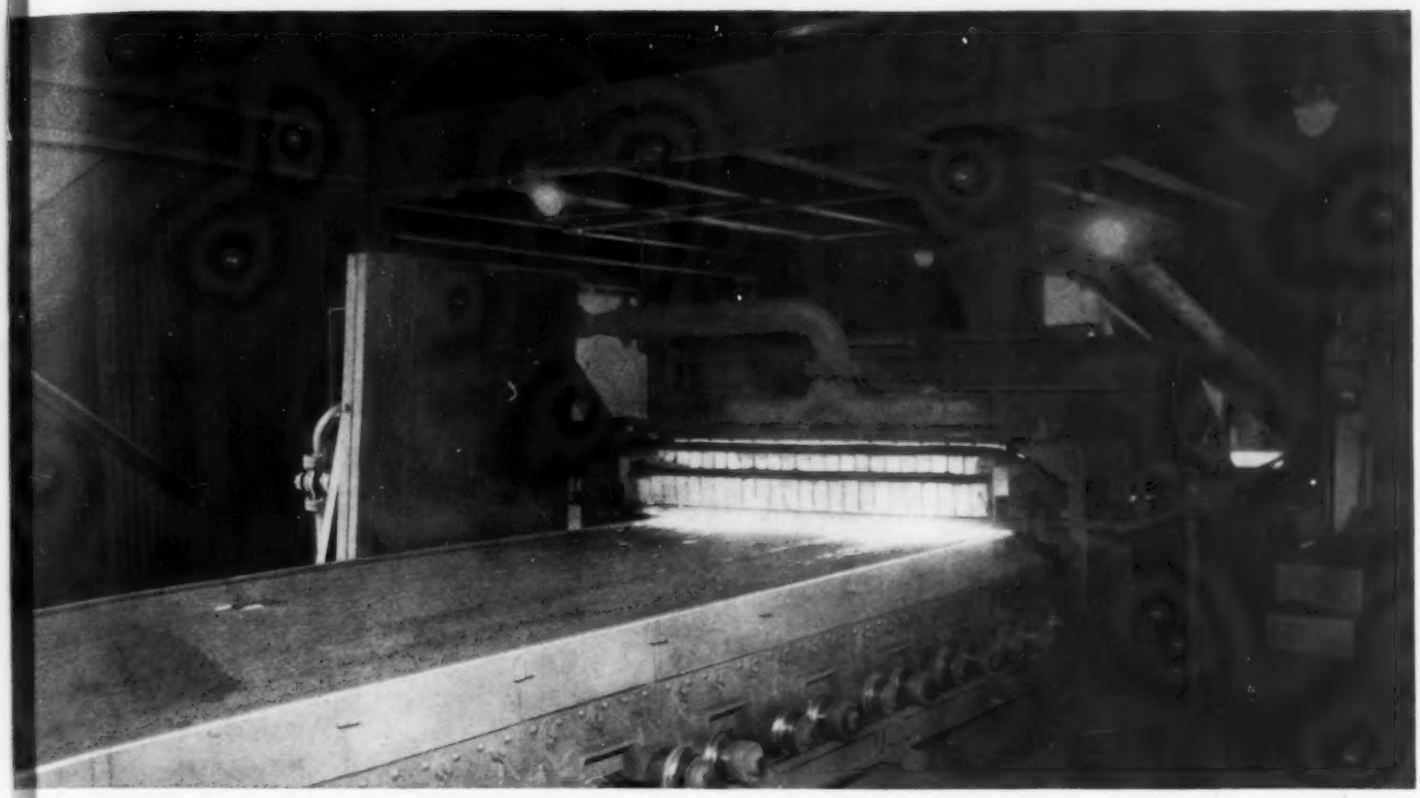
Centralized control of co-ordinated drives in G-E equipped plant keeps individual feeders in step, helps assure 3000-tons-per-day output!

Maintaining the correct proportion of materials to be blended in a modern continuous sintering line is an easy matter—with co-ordinated G-E group drives. That's the case at this large steel mill, where they were supplied as part of an all G-E engineered job for a new sintering plant. These drives keep individual feeders in the same speed relationship to each other at all times, regardless of changes in the sintering line's speed. Result: the mixture is always right, and production keeps moving to the tune of 1500 tons per day for each of the plant's two sintering lines.

Working closely with machinery manufacturers who supplied the processing equipment, G.E. co-ordinated the entire electrical system from start to finish, saved the plant's operators time and effort, helped get production started without needless delays.

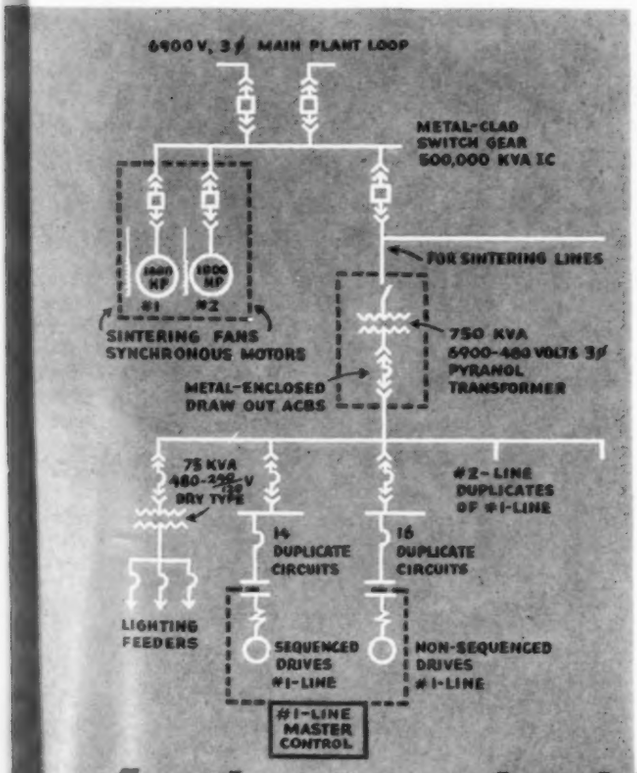
Your drive problems, too, can be solved just as successfully by calling in G.E. to work with your engineers and equipment suppliers. A G-E steel-mill specialist will gladly show you how. Call him at your nearest G-E office. *General Electric Company, Schenectady 5, New York.* 659-84

GENERAL ELECTRIC



Heart of the process is this sintering machine, driven by a G-E 15-hp adjustable-speed d-c motor. Swinging spout at far end deposits mixed material in layers on machine's traveling grates. Mixture is then ignited as it goes through an ignition burner, and burned on the grates as they move left. Sintering action is timed for completion at discharge end.

Centralized control of plant's two sintering lines is provided by this G-E master operator's panel. Included are push-button stations for starting and controlling various drives, metering and indicating equipment, and interlocking control that simplifies sequence operation of units, prevents pile-ups of material.



Here's the electrical story in brief: this modern sintering plant uses the unit control scheme, consisting of a master push-button control panel for remote drive control, grouped control centers that contain all motor starters, and load-center unit substations that step down primary 6900-volt power to 480-volt secondary power for smaller-hp motors. The two sintering-fan synchronous motors, each rated 1000 hp, 6600 volts, are powered directly by the incoming 6900-volt line and controlled through metal-clad switchgear.

Full-voltage starting is used to take advantage of its lower initial investment cost and easier maintenance for motors and control, as compared to the reduced-voltage method. Not shown in this simplified diagram is the raw-material-handling process, which precedes the actual sintering.

Another example of G-E drive engineering at work!

Vibrationless LIFTING POWER

300/60/20-TON, 4-GIRDER DOUBLE TROLLEY *Alliance* LADLE CRANE

● Building big cranes has been our business here at Alliance for more than 50 years. Whenever the industrial world has required cranes of large capacity, it has always found The Alliance Machine Company with designs and "know-how" to meet its requirements.

The 4-girder, double trolley ladle crane illustrated here was built for the Homestead Steel Works of the United States Steel Company to handle the increased Open Hearth capacity. It required a 4-story cage to house the electrical equipment to control the various motions of this crane. The three upper stories contain the magnetic control equipment and resistors. The bottom section of the cage houses the master controllers and the operator and is insulated.

This ladle crane is equipped with a two-motor, synchronized worm drive, interlocked double drum type main hoist. The synchronizing shaft employed in this scheme of gearing not only eliminates the undesirable ratchet gears but makes possible an additional safety feature in case one of the hoist motors fail. Under this condition both worms are driven by the remaining motor and all gearing functions as with two motors. In case of failure of one hoist motor on the conventional drive without the synchronizing shaft, hoisting is accomplished by only one set of gears. This imposes a double load on active gearing, the second drum being driven through the interlocking drum gears. The hoist gearing is so proportioned that the full capacity of the crane can be lifted by one motor without exceeding the quarter-hour rating.

The drum gears and pinions of the main hoist of this new crane have precision-cut, single-helical teeth, and in cooperation with the worm drive, assure vibrationless operation on either high or low speed hoisting and lowering.

All gears are fully enclosed and operate in a bath of oil, assuring long life and low maintenance.

The 4-part safety rope system installed on this crane affords the highest degree of safety in rope reeving.

Why not consult The Alliance Machine Company engineers when you have heavy material handling problems?

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

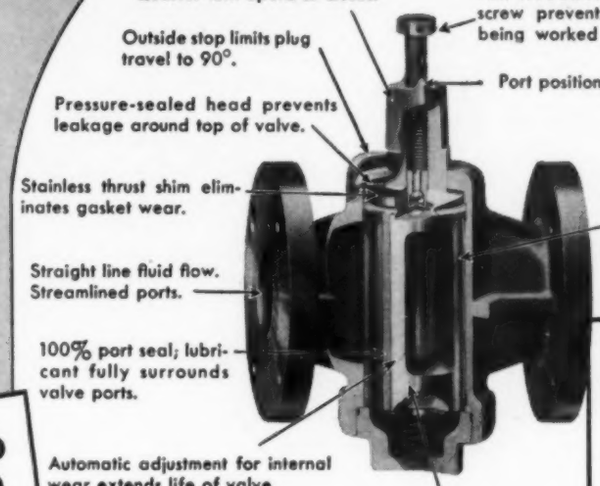
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

We Make ALL Types of PLUG VALVES

ONE OF THEM IS THE RIGHT VALVE FOR YOUR NEEDS

HOMESTEAD-REISER "Self-Seald" LUBRICATED PLUG VALVES

Straight-way— Worm & Gear Operated


Quarter-turn opens or closes.
Full threaded lubricant screw prevents dirt from being worked into valve.
Outside stop limits plug travel to 90°.
Port position indicator.
Pressure-sealed head prevents leakage around top of valve.
Stainless thrust shim eliminates gasket wear.
Self-Seald — Wedge action of divided plug gives extra tight seal against leakage.
Straight line fluid flow. Streamlined ports.
100% port seal; lubricant fully surrounds valve ports.
Automatic adjustment for internal wear extends life of valve.
Sealing surfaces protected from corrosive or erosive line fluids.

Flow Changer— Non-lubricated

HOMESTEAD CAM-SEALD (dry seat)

HOMESTEAD LEVER-SEALD (quarter turn)

How the Amazing "Self-Seald" Principle Works

Homestead-Reiser's patented "Self-Seald" principle is, we believe, the simplest and most effective sealing principle yet developed for lubricated plug valves.

In addition to a full lubricant seal around the ports, and around the top and bottom of the valve, the wedge-action of the divided plug under line pressure, causes the finely-finished surfaces of both segments of the plug to press outward against the sealing surfaces of the body.

This self-sealing action keeps the plug surfaces in contact with the mirror-like bore of the body. The plug automatically adjusts itself for wear, thus assuring extra long life and maximum leakless service.

For complete information, sizes and prices, write for Catalog 39-5. No obligation.

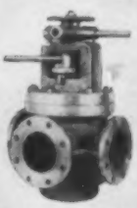
Straight-way— Flanged or Screw Ends

Straight-way— Flanged or Screw Ends

Three-way— Screw or Flanged Ends

Four-way— Flanged or Screw Ends

Four-way— Flanged or Screw Ends



Three-way— Flanged or Screw Ends

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 21 *"Serving Since 1892"* CORAOPOLIS, PA.

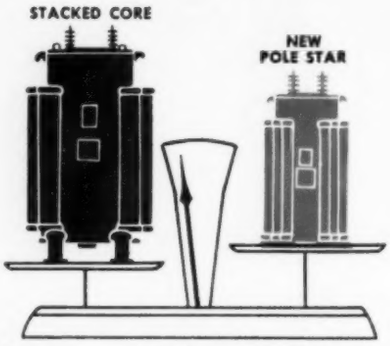
NOW..POLE STAR TRANSFORMERS

167 Kva

Pennsylvania's four new Pole Star distribution transformers are fundamentally the same as the original 3 to 100 Kva Pole Stars. Cores are wound of oriented electrical steel with core laminations individually lapped for low exciting current. In every Kva rating, the Pole Star is lighter in weight and smaller in size than the stacked core transformer it replaces. It is more economical to operate, less costly to store, and easier to install.

In Short, **The Pole Star is a Better Transformer . . . Operating with *Greater Efficiency* and at *Less Cost***

Exciting Current reduced 75%



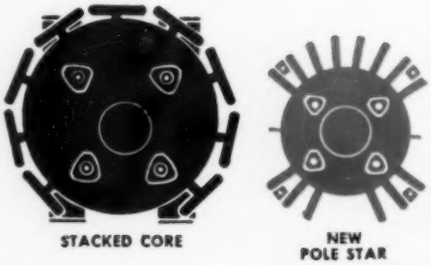
Weight reduced 2200 pounds

Compare

THE NEW 500 Kva POLE STAR WITH THE OLD 500 Kva STACKED CORE TRANSFORMER

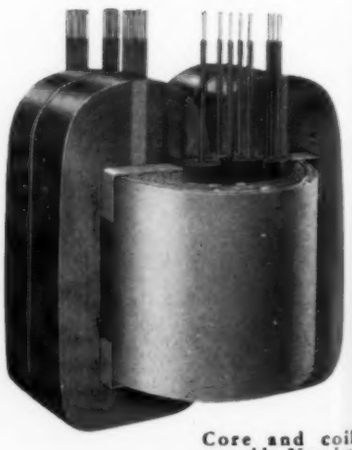
Oil Volume reduced 35%
125 gallons

Floor Area reduced 20%



LOW CORE LOSS—AN OUTSTANDING FEATURE OF THE POLE STAR

Pole Star cores are carefully annealed in controlled-atmosphere furnaces, but do not suffer the disadvantages of adhesions. That is because when the core is assembled through the coil, the laminations are separated from each other. The absence of adhesions between laminations and the presence of high interlamination resistance keep the core loss at a low value.



Core and coil assembly. Note lap joint at top of core.

PENNSYLVANIA TRANSFORMER

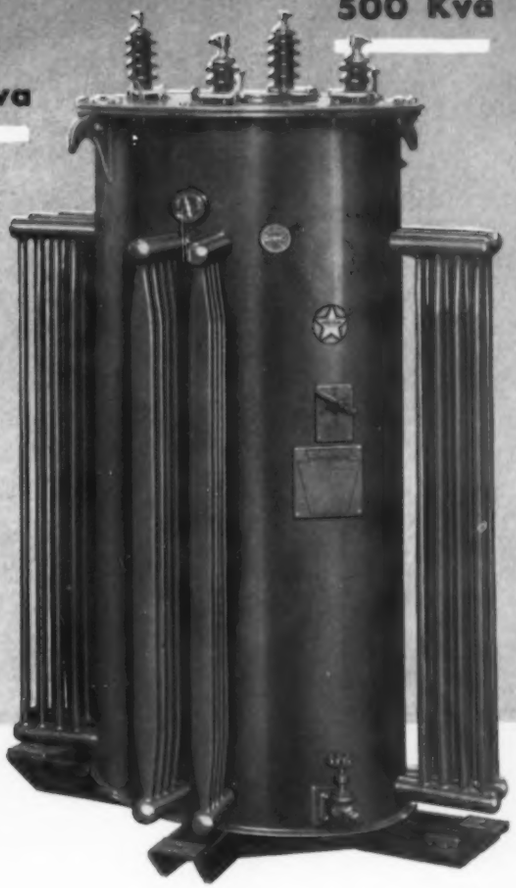
BOX 330 • CANONSBURG, PENNSYLVANIA • GREATER PITTSBURGH DISTRICT

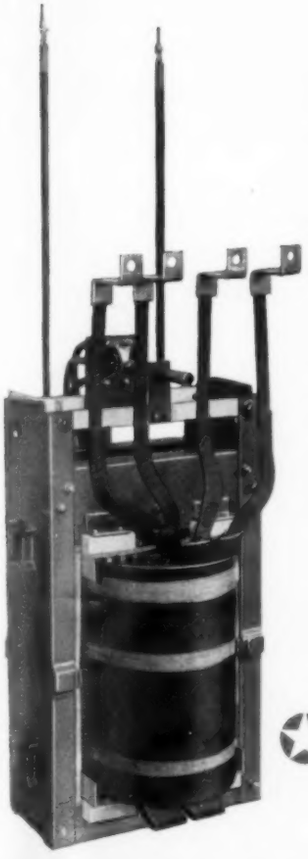
IN SIZES UP TO 500 Kva

250 Kva

333 Kva

500 Kva





NEW BASE FEATURES CROSS VENTILATION

Structural steel bars are welded to the tank bottom. Their arrangement permits the transformer to be rolled in any direction. Jack lugs extend beyond the tubes or radiators. Openings provide cross ventilation for the tank bottom and the base. The entire tank bottom is accessible through the openings for painting.

INTERNAL ASSEMBLY OF 167 KVA POLE STAR

Side frames completely enclose the core and provide a sturdy support for the entire unit. The Pole Star coil is designed for a low temperature gradient and a high overload capacity. Large oil ducts are provided throughout the coil.

CORE BUILDER ASSEMBLES LAMINATIONS THROUGH 500 KVA POLE STAR COIL

Core laminations are individually lapped. There are no gaps or butt joints in the Pole Star core to cancel out the advantages of the cold-reduced, oriented electrical steel. The lapped construction reduces the flux density at the joint and maintains the low reluctance path of the Pole Star core.

R COMPANY

Pennsylvania TRANSFORMERS

Product Of Long Experience
Safe, Thrifty And Reliable

What's YOUR Bulk Material Handling Problem?

* COKE BREEZE
* DOLOMITE
* COAL
* SAND
* COKE
* OTHER BULK MATERIALS

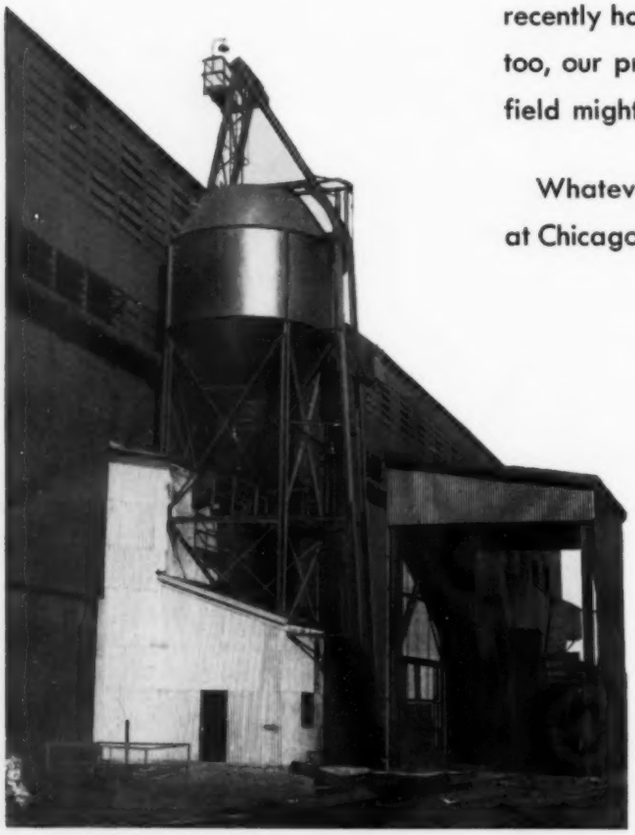
When you have engineering and construction problems connected with handling and processing bulk materials, consult Roberts and Schaefer Company. It's best to call R&S engineers during early planning stages — but it's a profitable decision at any time, whether your plans are started or not.

We are equipped to engineer and erect any plant for storing and handling bulk materials, and for processing them too.

For more than 50 years we have been engaged in this specialized type of engineering and have designed and erected complete plants for the mining, railroad and allied industries.

To our long list of installations for coal preparation, for storing and processing coal, coke, sand, and other bulk materials, we recently have added plants for coke breeze and dolomite. Then, too, our present research into the sintering and ore reclamation field might also interest you.

Whatever your problem . . . phone or write us today — either at Chicago or one of our branch offices — no obligation of course.



Coke Breeze Storage and Service Plant, United States Steel Company
Gary Steel Works, Gary, Indiana

R AND S COMPANY

ROBERTS and SCHAEFER CO.

ENGINEERS AND CONTRACTORS
130 North Wells Street, Chicago 6, Illinois

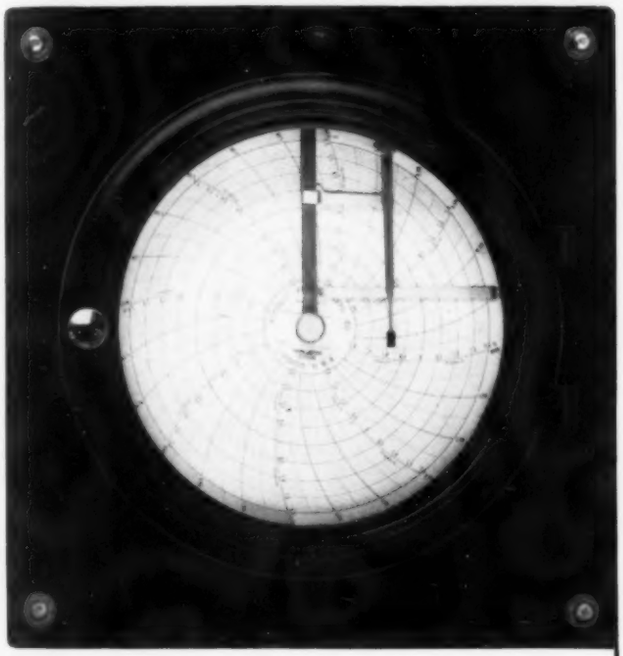
PITTSBURGH 22, PA.
HIBBING, MINN. (Box 675)
HUNTINGTON, W. VA.
NEW YORK 19, N. Y.

accurate— sensitive— trouble-free— easy to service—

Four reasons for choosing these Republic Low Pressure Instruments to measure flow or pressure of gas and air

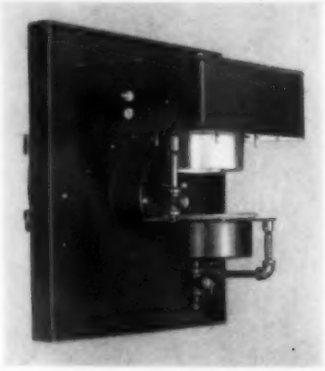
in

OPEN HEARTH FURNACES
SOAKING PITS
REHEATING FURNACES
COKE OVENS
SMELTING FURNACES

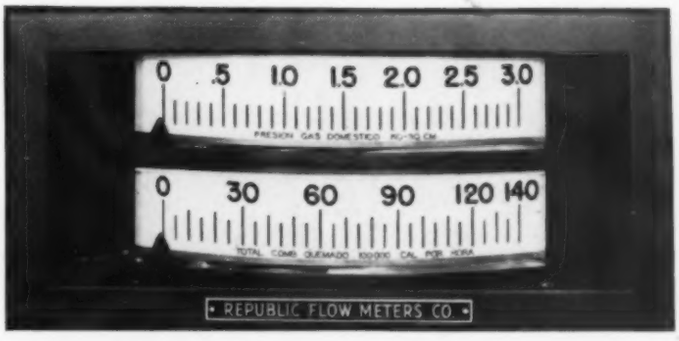


Republic Oil Sealed Bell Recorder at left responds to the slightest changes in furnace pressure and stack draft, and works independently of other controls. Operating principle is so simple that a minimum of maintenance is required. Sealed bell withstands high temperatures and will not crack, rupture or wear out. For pressure or vacuum measurement, the Recorder may be connected directly to a furnace or pipe line. For differentials, it may be connected across an orifice.

Recorder has ranges 0-0.2″ H_2O and 0-8″ H_2O at static pressures to 10 psi. On low range, large 4″ diameter bell gives sensitivity of ±.001″ H_2O.



For quick periodic inspection and cleaning, mineral oil reservoir at rear of Recorder may be lowered by disconnecting one pressure connection and four bolts. Calibration is not changed.

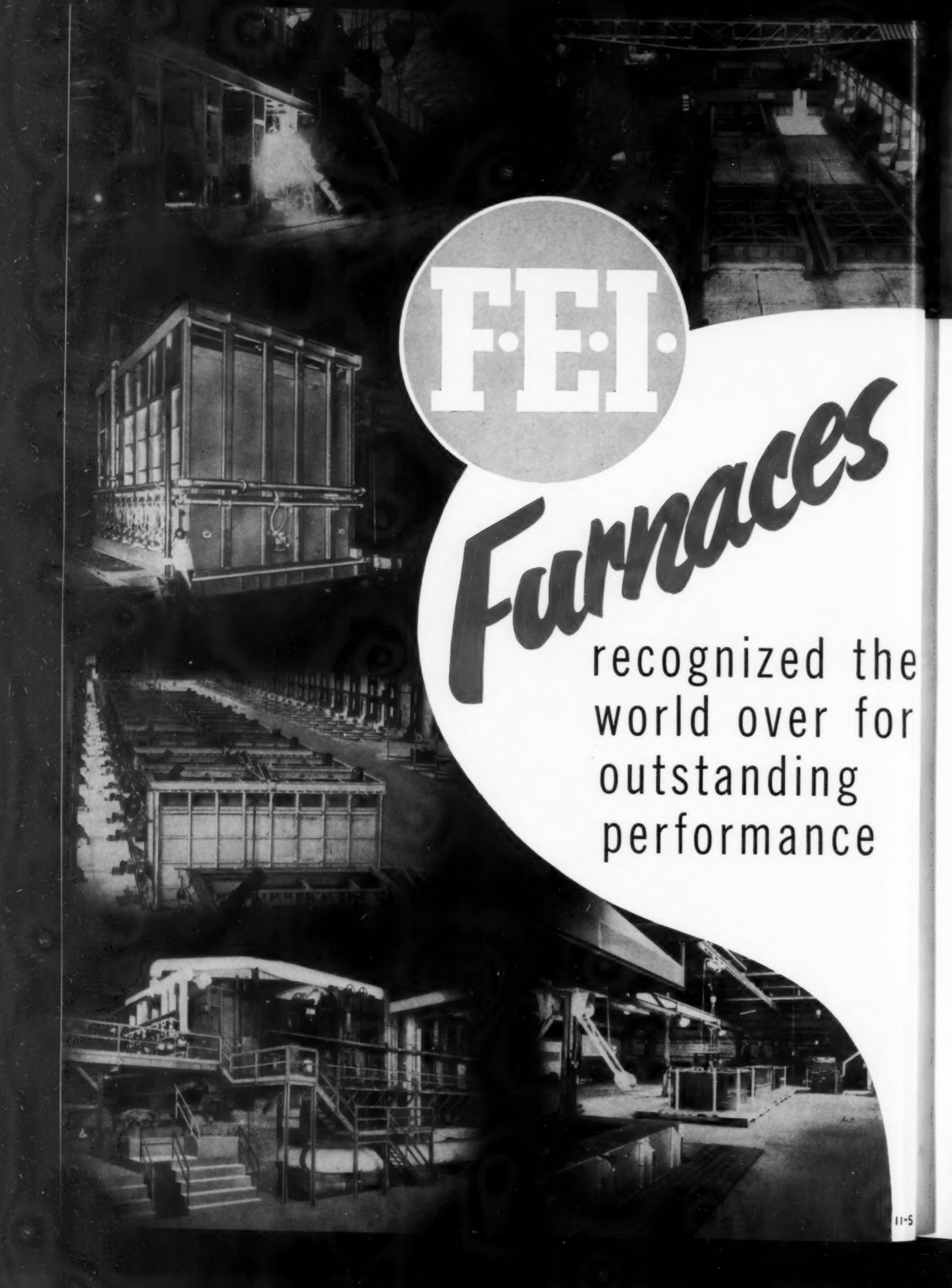


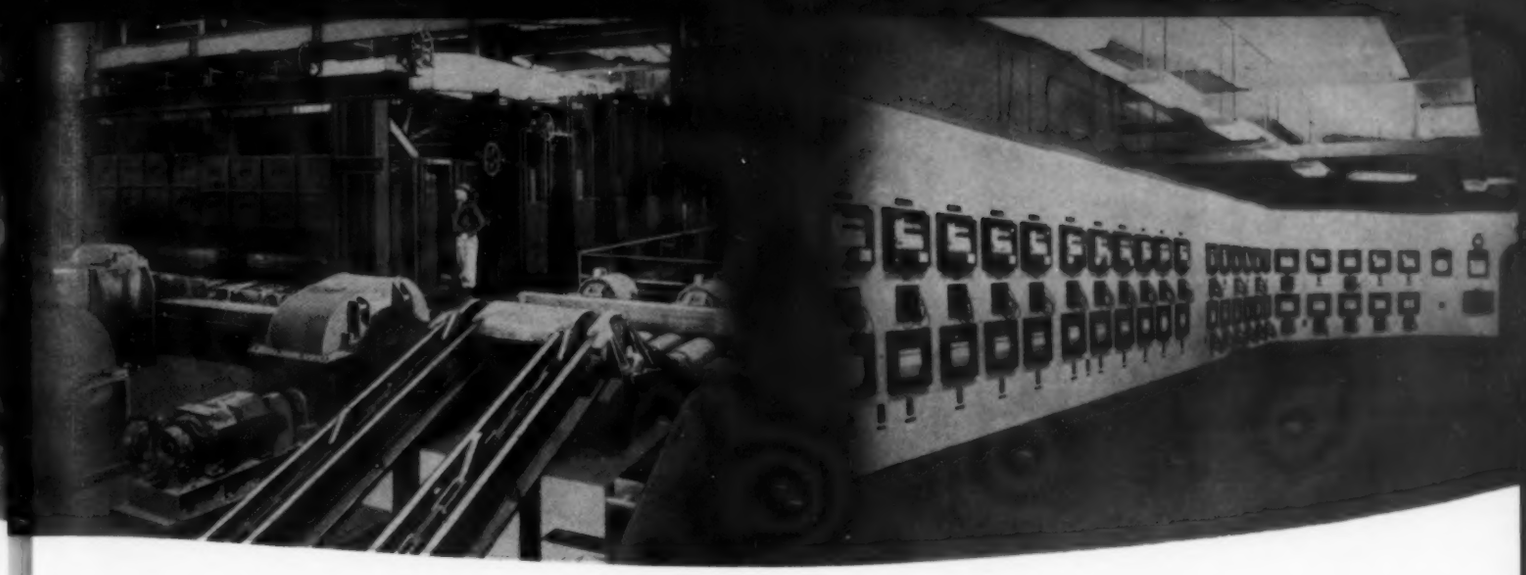
Horizontal Indicator is operated by a tough, resistant diaphragm made of polythylene plastic. Each Indicator is separate and may be individually removed or adjusted. Indicator arm swings on jeweled bearings for friction-free accuracy. Internally illuminated scales may show pressure, draft, pressure-draft combination or differential pressure. Ranges from 0-0.2″ H_2O to 0-40″ H_2O.

Two Indicators are often mounted together to read air flow—gas flow ratio in furnace firing. They may be calibrated so their pointers line up when air and gas are in the correct ratio.

Both instruments fully described in Bulletin 802. Write for your copy today.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois


F·E·I·
Furnaces
recognized the
world over for
outstanding
performance
11-S



In America and abroad, plants large and small, report increased output, lowered cost and improved metallurgical quality . . . thanks to F.E.I.'s advanced heating methods. The advantages of Furnace Engineers' patented, automatically controlled combustion system, backed by many actual case histories, merit your consideration. For any type of furnace—any fuel—you can rely on F.E.I.

OPEN HEARTH FURNACES .... *Any capacity you need*

SOAKING PITS .... *Regenerative and One-Way Recuperative*

CONTINUOUS REHEATING FURNACES .... *Slabs, Billets, Blooms*

FORGING FURNACES .... *Built to Meet Your Requirements*

ANNEALING and NORMALIZING FURNACES

.... *Gun Tubes, Shells, Bombs, Armor Plate*

DIRECT FIRED BELL TYPE ANNEALING FURNACES

.... *Coils, Sheets, Wire, Bars*

GALVANIZING FURNACES

....*Tubes, Sheets, Metalware, Jobbing*

Furnace Engineers, Inc. service is *complete*. One F.E.I. contract covers everything—from the preliminary analysis of your specific needs to final operational check-ups. The F.E.I. staff includes engineers with up to thirty-five years of experience . . . specialists in the design, construction, installation and operation of all types of industrial furnaces. For either a completely new installation or a modernization job, inquire about F.E.I. service.

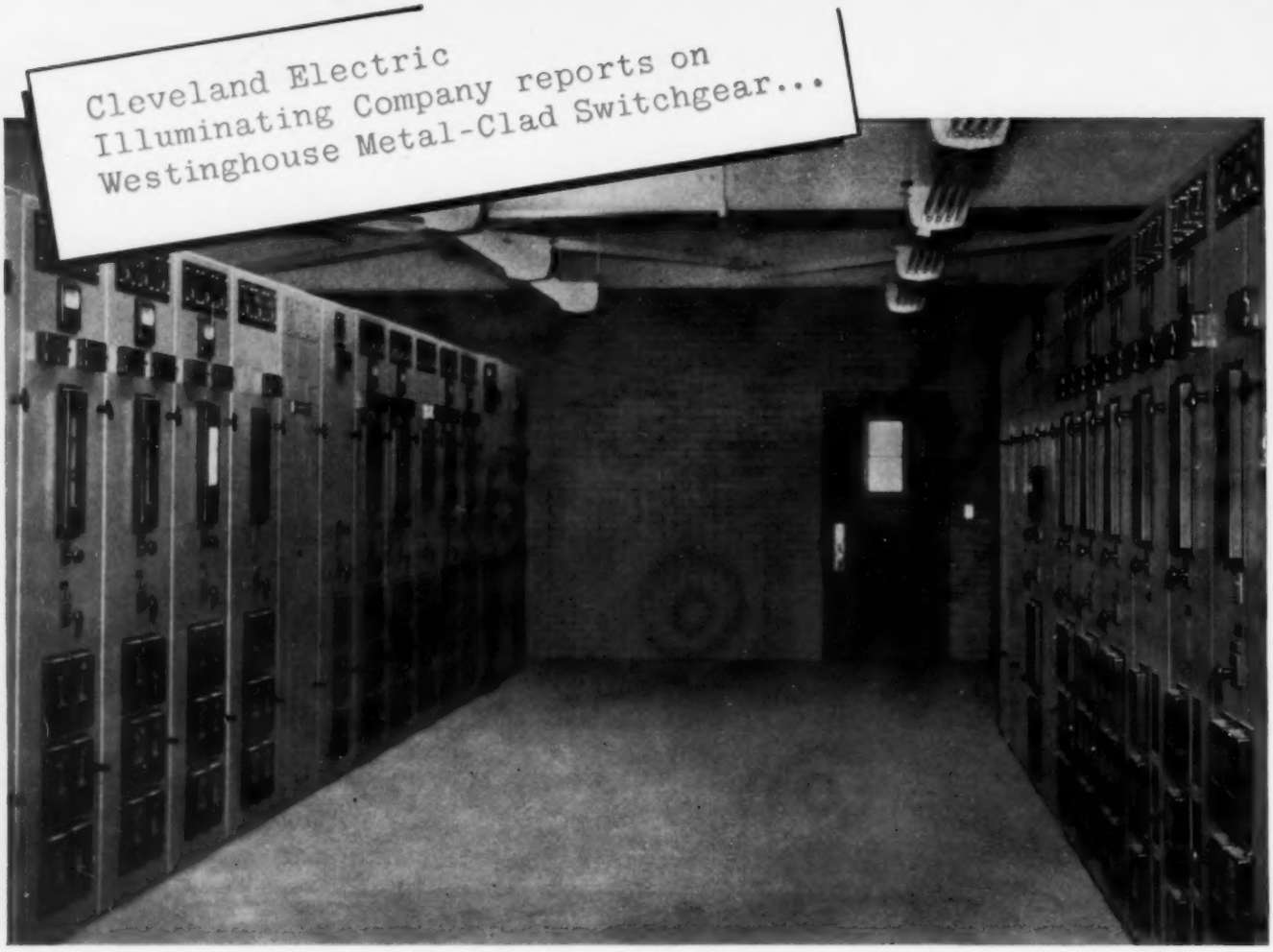
OTHER HEATING LINES TO MEET YOUR SPECIFIC NEEDS

Complete, New Installations or Modernization of Existing Furnaces

Furnace Engineers, Inc.

F.E.I. BUILDING, 1551 W. LIBERTY AVE. PITTSBURGH 16, PA.

AFFILIATES — *Great Britain:* Salem Engineering Co., Ltd., Milford near Derby, England;
France, Belgium, Holland, Luxembourg and Italy: Heurtey & Co., 38 Av. G. Mandel, Paris XVI, France.



"Keeps Maintenance Cost Down!"

At the Cleveland Electric Illuminating Company's Ridge Road Substation, this installation of Westinghouse Metal-Clad Switchgear is setting an excellent service record. And what they say about it suggests a savings opportunity for you:

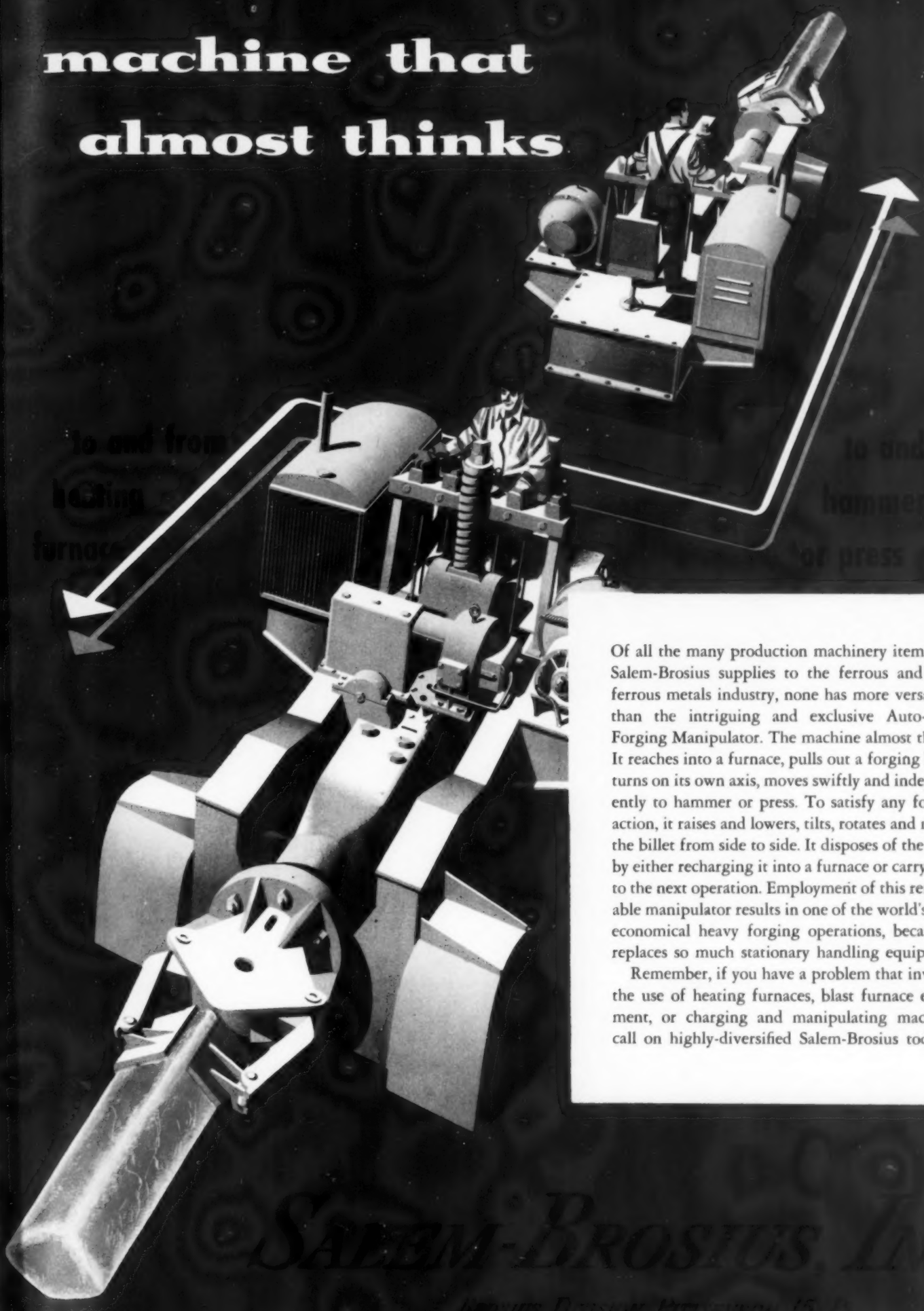
> *"We particularly like its low maintenance characteristics. In two years of operation, there has been a minimum of inspection and maintenance. Expected result is an appreciable long-range saving."*

Some of the features contributing to this saving are easy accessibility to component parts, simple, fast removal and replacement of draw-out air breakers, and exclusive "De-ion"® circuit interruption.

The complete story of the savings possibilities of Westinghouse Unitized, Metal-Clad Switchgear is contained in Booklet B-5306. For your copy write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-60767

YOU CAN BE SURE...IF IT'S
Westinghouse
METAL-CLAD
SWITCHGEAR

machine that almost thinks



Of all the many production machinery items that Salem-Brosius supplies to the ferrous and non-ferrous metals industry, none has more versatility than the intriguing and exclusive Auto-Floor Forging Manipulator. The machine almost thinks. It reaches into a furnace, pulls out a forging billet, turns on its own axis, moves swiftly and independently to hammer or press. To satisfy any forging action, it raises and lowers, tilts, rotates and moves the billet from side to side. It disposes of the piece by either recharging it into a furnace or carrying it to the next operation. Employment of this remarkable manipulator results in one of the world's most economical heavy forging operations, because it replaces so much stationary handling equipment.

Remember, if you have a problem that involves the use of heating furnaces, blast furnace equipment, or charging and manipulating machines, call on highly-diversified Salem-Brosius today.

SALEM-BROSIUS, INC.

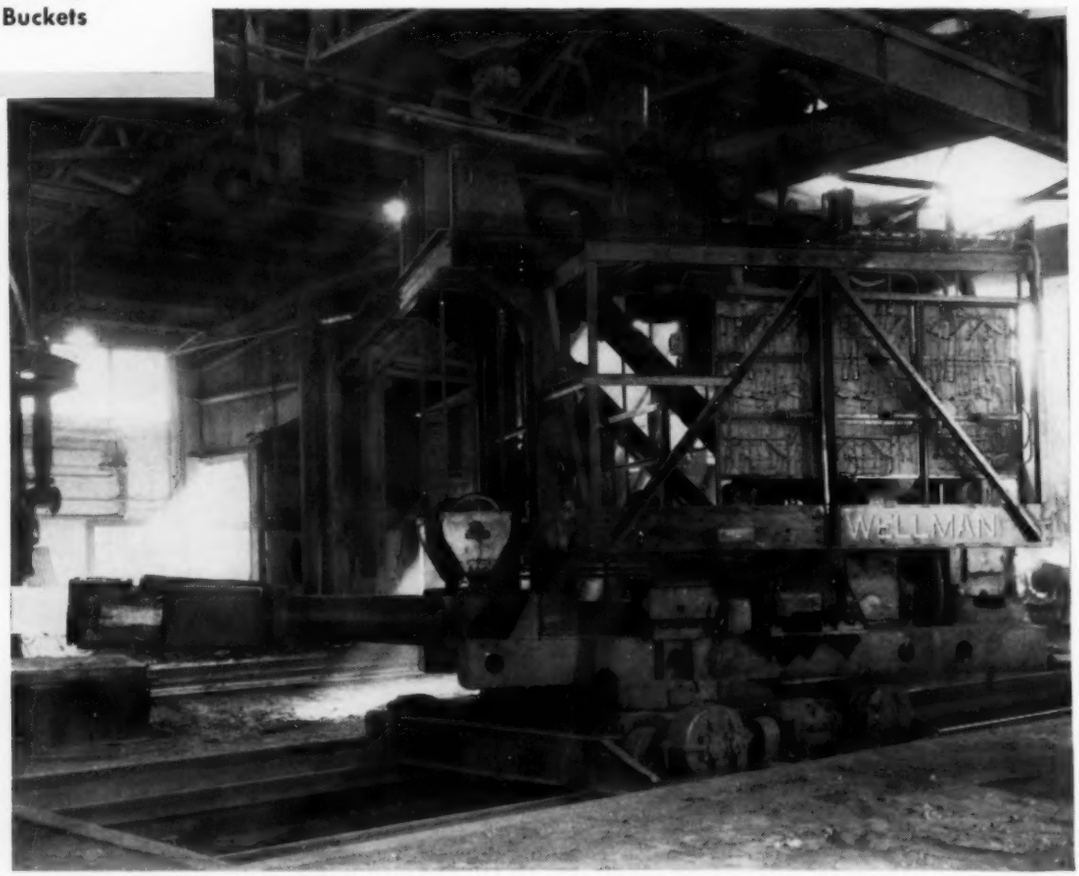
Engineering Division, Pittsburgh 15, Pa.
Salem Engineering Div., Salem, Ohio

Wellman will build it

Special Cranes
Forging Manipulators
Charging Machines
Ore Unloaders
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Skip Hoists
Ore and Coal Bridges
Clamshell Buckets

→ Wellman forging manipulators

handle big ingots
speedily, efficiently



Wellman Forging Manipulator with white-hot ingot ready for forging.

● Wellman Forging Manipulators hold hot steel ingots on anvil dies, turn them and keep them level for efficient forging . . . despite hammering shocks. You can count on *all* Wellman equipment for speedy, economical service. It is backed by more than a half century of leadership in designing manufacturing and construction of heavy materials handling facilities.

THE WELLMAN ENGINEERING COMPANY

7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

Customers TELL US about

NATIONAL
TRADE-MARK

Standardized Brushes!

STANDARDIZATION of industrial motor brushes means different things to different people. But no matter how they define it, National Carbon's pioneer brush-standardization program is making their jobs *easier,* helping them do *better* work, *saving* their company *time* and *money.*

PRODUCT– "Practically every machine and part in this plant is *standardized,*" said one Chief Electrician. "Why not brushes, too? The quality of our own products is constantly being improved through standards procedure." **HE'S RIGHT!** Brushes are no exception to the rule that volume production of *standard* items results in greater uniformity, closer control of materials and processes.

PRICE AND DELIVERY– "Standardization?" said this Purchasing Agent. "If that's what's behind your FLAT PRICE deal, I'm for it! I don't have to worry about quantity discounts and your on-the-button deliveries take a real headache out of inventory!"

HE'S RIGHT, TOO! Standardized brushes are mass-produced *for* stock . . . shipped *from* stock at the same low, FLAT price for 100 or 100,000 brushes!

PACKAGE–"You wouldn't believe how many different ways brushes are packed," one Stores Keeper told us. "Bags, barrels, boxes of every size and shape. But National Carbon's *standardized* cartons are tops. They pack neat, stack straight, are clearly marked and keep their shape."

RIGHT AGAIN! Mass production enables us to deliver a better package in a minimum number of carton sizes.

LOW LIGHT BILLS . . . mark phenomenal acceptance of "EVEREADY" No. 1050 Industrial Flashlight Batteries by a broad cross-section of industry. Delivering *twice the usable light* of any battery we've ever made before, it will not swell, stick or jam in the flashlight . . . has no metal can to leak or corrode.

Write for Bulletin CP-2426
"NATIONAL" STANDARDIZED BRUSHES

The terms "National", "Eveready" and the Three Pyramids device are registered trade-marks of Union Carbide and Carbon Corporation

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A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N.Y.

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CONTINUOUS WIRE PATENTING, PICKLING AND COATING LINE

by DREVER

Installed in the plant of
John A. Roebling's Sons Company
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Line Consists of

GAS-FIRED, MUFFLE TYPE HEATING FURNACE
GAS-FIRED IMMERSION TUBE HEATED LEAD QUENCHING BATH
COOLING ROLLS
ACID PICKLE TANK
HOT WATER SPRAY RINSE TANK
COATING TANK

CAPACITY, 3000 LBS./HOUR
HIGH CARBON STEEL WIRE
12 STRANDS 0.112" AVERAGE DIA.

Automatic Controls • Can be Electrically Heated
Substantial Savings in Labor Costs
High Quality Products

Send your inquiries and requirements for equipment to our competent staff of engineers and metallurgists

DREVER COMPANY

730 E. VENANGO STREET • PHILADELPHIA 34, PA.

AMSCO Blast Furnace Small Bell Rings Up a Record

Over a million-and-a-half tons of material battered past it during a full furnace campaign!

When you don't have to stop steel production to change Blast Furnace Small Bells during a furnace campaign, production can only go in one direction—*up*.

A large midwestern steel company installed a small AMSCO Manganese Steel bell in its number 1 furnace in December 1944. 1,575,000 tons of limestone, coke, and iron ore and six-and-a-half years later, the bell was removed from the furnace *after a full campaign!*

When it was removed in August, 1951, the metal around the base had worn from an original thickness of 2¼ inches to one quarter of an inch.

At a time when continuous production is imperative, the use of Amsco Blast Furnace Small Bells, Seats, Bell Rod Shields, and Receiving Hopper Wear Plates will assure minimum distributor maintenance, help avoid shutdowns, and lost production.

Manganese Steel castings are service-proved in operations where high resistance to impact and abrasion are required.

American Manganese Steel is "the toughest steel known" for blast furnaces, coke plants, rolling mills, and foundry equipment parts. Whatever your requirements are, you'll get longer wearing life and greater economy when you specify AMSCO.

WHEREVER YOU MEET A PROBLEM OF WEAR CAUSED BY IMPACT AND/OR ABRASION . . .

. . . find out about longer-lasting, dollar saving manganese steel made by AMSCO . . . world's largest producer of Manganese Steel Castings for all industry.

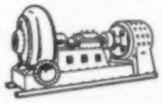
AMSCO controls impact and abrasive wear in 5 basic industrial operations:

Power Transmission

Mining and Excavating

Transportation

Crushing and Pulverizing



Materials Handling

AMERICAN Brake Shoe COMPANY

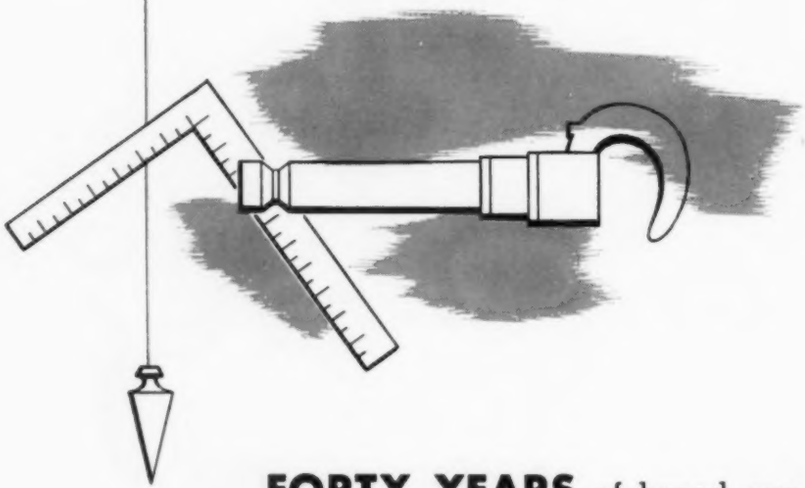
AMERICAN MANGANESE STEEL DIVISION

411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

STANDARD
BOILER & PLATE IRON CO.

ENGINEERING CONTRACTORS for the modernization, extension or rehabilitation of existing blast furnaces and steel mills, as well as the erection of new plants. FACILITIES include fabrication shops, supervisory personnel, erection crews and equipment.



FORTY YEARS of broad experience and demonstrated engineering skill in the construction and erection of plants and installation of equipment for basic iron and steel producers.

THE STANDARD BOILER & PLATE IRON COMPANY
C. A. BRASSERT, *President*
Offices: 210 Boulevard of the Allies • Pittsburgh 22, Pa.
SHOPS at NILES, OHIO

How to feed a leveler for less

...with help of TIMKEN® bearings

TO relieve stress and strain on flat rolled coil stock and give it better deep draw characteristics, it is uncoiled and passed through the pinch and leveler rolls of this McKay press feeder line. Maintenance cost is kept to a minimum and expensive breakdowns are avoided by using Timken® bearings throughout the entire press feeder line.

In the leveler unit, the outer races of 76 Type TNASWH Timken bearings serve as back up rolls. They have a surface finish of 15 micro-inches, minimizing scuffing and scoring. And because this bearing is *both* anti-friction bearing and back up roll, design is greatly simplified.

Timken bearings are also used on the coil reel head shaft to take the heavy load of the coil. And they're used on the pinch rolls to keep them in accurate alignment.

Line contact between the rolls and outer races of Timken bearings gives them extra load-carrying capacity. And due to their tapered construction, Timken bearings take both radial and thrust loads in any combination. Deflection and end-movement of shafts and rolls are kept to a minimum. No thrust washers are necessary.

No other bearing gives you *all* the advantages you get with Timken tapered roller bearings. Whether you build or buy machinery of any type, specify Timken bearings. And look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

McKAY MACHINE COMPANY uses this Type TNASWH Timken bearing as a combination anti-friction bearing and roll in the leveler unit of the McKay press feeder line.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

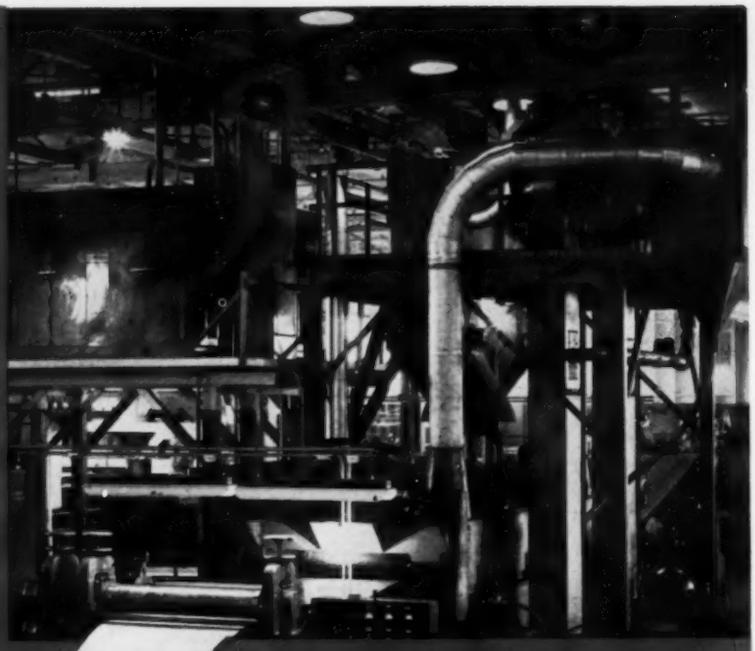
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION ✳

WHEELABRATOR®

Mechanical Cleaning

descales steel strip



. . . cheaper than pickling

saves valuable floor space

at Rome Cable Corporation

The economies and high speed production of the airless Wheelabrator method of mechanical descaling of hot rolled steel strip are reflected in this typical installation in the Torrance, California plant of the Rome Cable Corporation, manufacturers of electric weld heavy wall conduit.

The airless Wheelabrator method was selected by Rome Cable Corp. because it was the only process that would economically remove surface scale and permit the rest of the plant to maintain its high production without consuming a major portion of the plant area. Whereas approximately 175 lineal feet of floor space would be required for acid pickling, the Wheelabrator cabinet takes up only 25 lineal feet.

The steel strip is descaled prior to slitting for less than the cost of acid pickling. Another important saving is realized in the fact that the Wheelabrator removes scale only . . . there is no loss of virgin metal.

Wherever steel is processed in large quantities, the possibilities for saving money with a Wheelabrator are tremendous. We would be glad to demonstrate these savings for you. Write today for full details.

WHEELABRATOR — The perfected airless centrifugal blast unit pioneered by American scours away scale and dirt mechanically at low cost. Provides a more uniform etch for mill rolls, effects unusual economies in cleaning strip, sheet, bar stock and skelp.

American

WHEELABRATOR & EQUIPMENT CORP.

396 S. Byrkit St., Mishawaka, Indiana

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST CLEANING EQUIPMENT

Farrell-Cheek

PRESENTS A NEW CONCEPTION OF ALLOY STEEL CASTINGS IN MODERN INDUSTRY • • •

• • • because when you buy a Farrell-Cheek casting you buy the benefits of all the 42 years of Farrell-Cheek experience in supplying fine cast steels. You receive engineering service that assures accurate design, according to your specifications. You get the benefit of completely modern facilities that deliver quality cast steel parts • • • carbon and alloy • • • unmachined or completely finished.

This combination of expert engineering and quality production has overcome many difficult problems. Intricate core work — thin sections — special steels — all point to the ultimate use of Farrell-Cheek steel castings. We developed special alloys like Farrell's "85" and "Hard Edge" that combine high yield point, toughness and rigidity with resistance to wear and excellent machinability to give you a truly tailor-made product.

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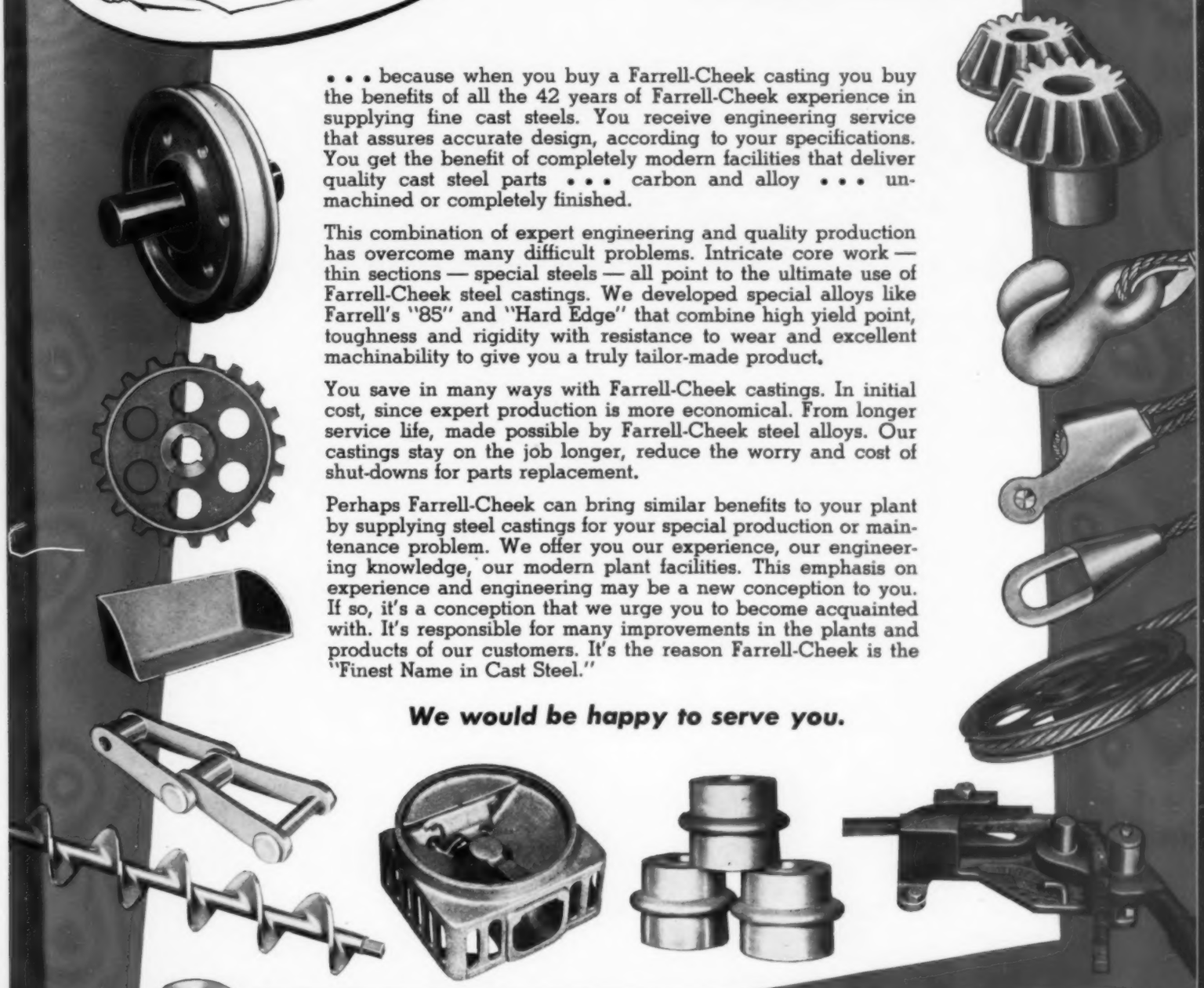

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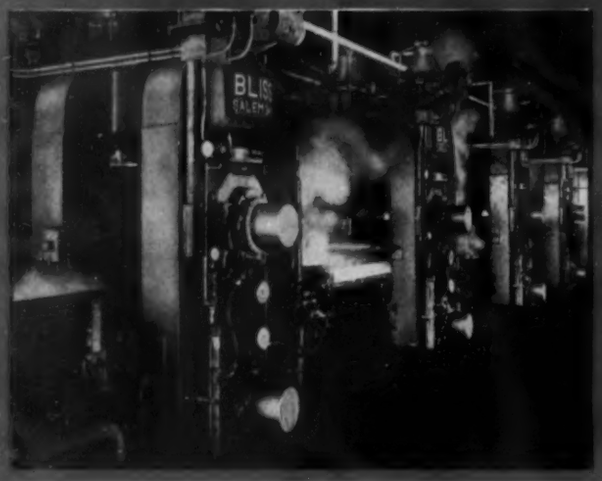
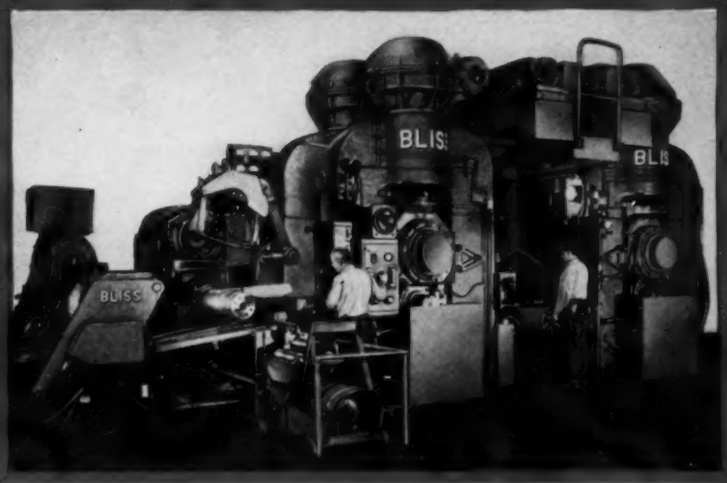
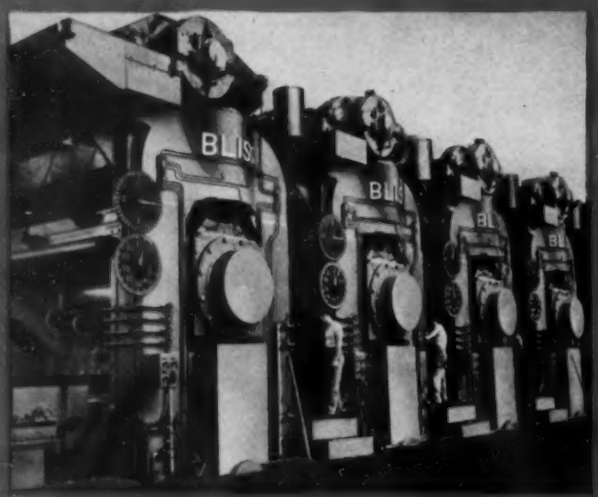


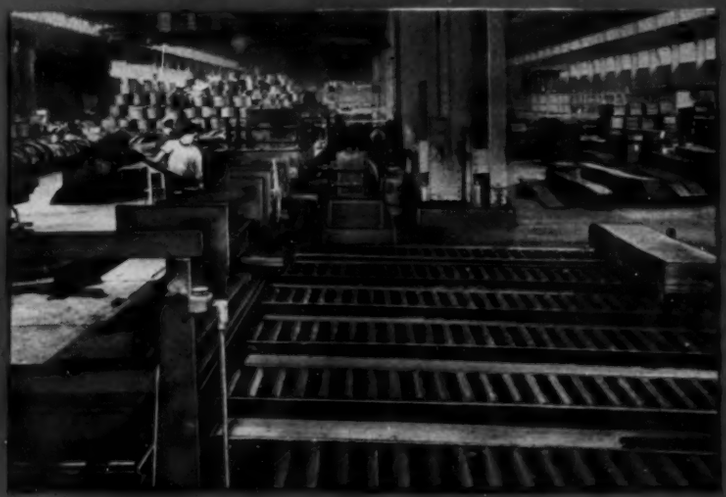
HOT-ROLLING STAINLESS · A Bliss 24″, five-stand hot finishing train handles all the hot-rolling of stainless and "specialty" steels at Superior Steel Corporation. Since the thin stainless is slit into narrow strips, extreme accuracy and flatness are vital.



BRASS TANDEM · Brass and copper breakdown is the job of this Bliss four-high, two-stand tandem strip mill at the Springdale, Conn., plant of Stamford Rolling Mills Company. Bliss coiler, at far left, coils flat bars. Tension reel winds lighter-gage coils. A coil mandrel and elevator permit quick handling of heavy-gage coils.



HOT-ROLLING ALUMINUM · This five-stand, four-high 80″ tandem mill hot-rolls aluminum sheet strip. Engineered and supplied complete by Bliss for a leading aluminum producer, this mill includes all necessary special auxiliaries such as roll brushers, guides and up coilers.



UP-CUT SHEAR LINE · Coiled steel is converted into uniformly flat sheet blanks at speeds up to 240 fpm by this shear line, designed by Bliss for Alan Wood Steel Company's 30″ hot mill. The Bliss continuous shear line performs nine operations—from feeding to piling. It is suited for use in steel, brass and copper mills or fabricating plants.

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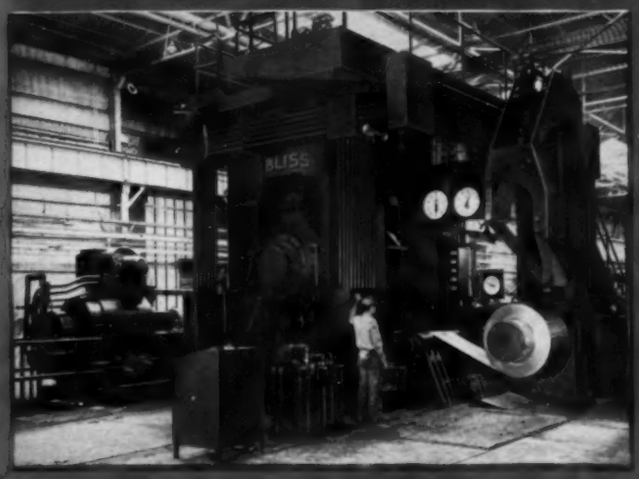
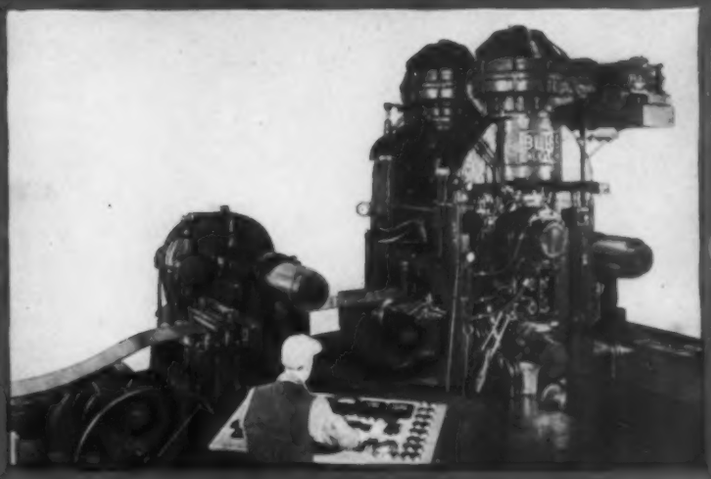
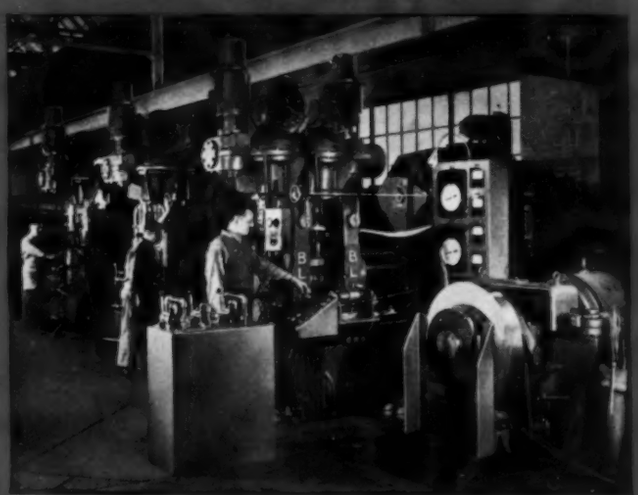


STEEL TEMPER PASS · Bliss four-high temper-pass mill, installed at the South's leading steel plant, rolled a record tonnage of steel in eight hours. Here, it tempers 20-gage steel at 3500 fpm, handles 30- to 13-gage, 20″ to 48″ wide. It handles sheet stock coils up to 72″ in diameter.



FOUR-HIGH REVERSING · This four-high reversing cold reduction mill, specially designed by Bliss, proved to be the answer to the Greer Steel Company's "varied" requirements—a rugged, versatile mill to maintain exacting standards for quality of finish and accuracy of gage on short runs and quick changeovers.



COLD-ROLLING STAINLESS · The steel plant for whom Bliss built this three-stand, two-high mill reports a 50% average reduction in a single pass; accurate cold-rolling and finishing of stainless and special alloys within .0005″ overall; 'round-the-clock operation at speeds up to 600 fpm.

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Crops *and* Shorts

AS dissatisfaction and unrest among steel workers over union leaders' insistence on the union shop become evident, union heads become more and more ridiculous in their statements designed to whip up the faltering ranks.

David J. McDonald, secretary-treasurer of the United Steel Workers calls the fight for the union shop a "fight for industrial democracy," and says the steel companies want to "impose a system under which a man can't call his job his own."

James J. Thomas, director of USW District 15, calls the letters sent to employees' homes by the steel companies "phony," and said, "The vicious approach to the employees and the public is the worst example of primative union-busting activity I have known." He also said that if conditions sought by the industry were granted, one out of four mill workers would lose their jobs.

How silly can you get!

▲

IN the light of such statements, it isn't surprising that Phil Murray's challenge to C. F. Hood, of United States Steel, to a public debate on the steel strike issues was turned down. Why play with a stacked deck? Of course, maybe Mr. Hood would be willing to debate if Mr. Murray would agree to a properly supervised vote of steel workers on accepting the companies' last offer.

▲

THERE'S probably as much horse sense as there ever was. Maybe the horses have it.

▲

ISN'T it odd that the same government that is arguing so strongly against forcing prisoners of war to go back to their own country against their will nevertheless favors forcing its own citizens to join a union in order to get or keep a job?

▲

PRESIDENT TRUMAN, to whom the steel strike appears to be "a conspiracy against the public interest and not a labor dispute," says the situation does not call for use of the Taft-Hartley law.

Meanwhile, the United Steel Workers filed unfair labor practice charges, under the Taft-Hartley law, against the six largest companies, claiming the companies of conspiring to prevent collective bargaining and of refusing to bargain in good faith.

Well, it just depends on which part of the chicken you like — dark meat or white meat.

FOLLOWING Weirton Steel Co.'s granting of a wage increase to its employees, the company filed an application for a price increase of $5.50 per ton. Copies of the request were delivered to the offices of Economic Stabilizer Roger L. Putnam, Acting Mobilizer John R. Steelman, and Price Stabilizer Ellis Arnall. On the following day, all three agencies declared they had not received the application. Subsequently, after investigation, Mr. Putnam's office found the missing document. The department secretary who received it had immediately routed it to "correspondence" who had passed it on to the agency's chief economist, who was studying it.

▲

IF all the bureaucrats in Washington were laid end to end, they still wouldn't reach any conclusion.

▲

ESTIMATES by the American Iron and Steel Institute show a steel production loss of 262,000 tons per day during the strike. As of July 1, this means a loss of about 38,500,000 tons of steel because of major strikes since the end of World War II.

The Institute also reports the net income of the industry for the first quarter of 1952 as 4.7 cents on each sales dollar, as compared to 5.7 cents in the preceding quarter, 6.2 cents in the first quarter of 1951, 8.0 cents in 1950 and 8.3 cents in the period of 1921-1930.

▲

GARDENING is an early symptom of lumbago.

▲

LEHIGH University reports that its engineering graduates are being offered starting salaries averaging $325 a month, with one man starting at $500.

▲

A LETTER from the Federation of New York State Bird Clubs states that "lead poisoning is taking an all too heavy toll on winged or crippled waterfowl," and asks whether it is possible for "iron companies to make (at a price with lead pellets) low carbon iron pellets for use in shotgun shells, thereby replacing the poisonous lead pellets. Think of the business the iron companies could get from the shells of the country's duck hunters."

▲

NEARLY 2,000,000 automobile casualties — an all-time high — were recorded in 1951. Traffic deaths totaled 37,100 and the injury count soared to 1,962,000.

▲

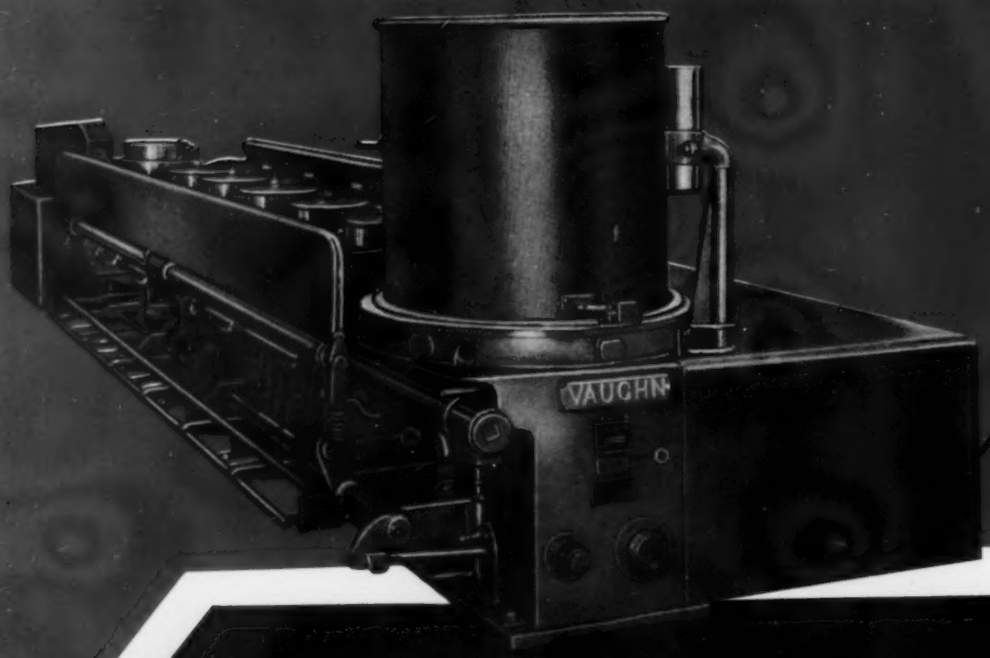
A SALESMAN should never be ashamed of his calling, but rather, of not calling.

▲

FEW people study to discover the truth; most of us seek to confirm our errors and perpetuate our prejudices.

▲

AFTER viewing national political conventions on television, we are convinced that television can make a major contribution to the advancement of American government. Eventually, enough people will become disgusted with the convention system of nominations to force a change to direct voting for candidates.



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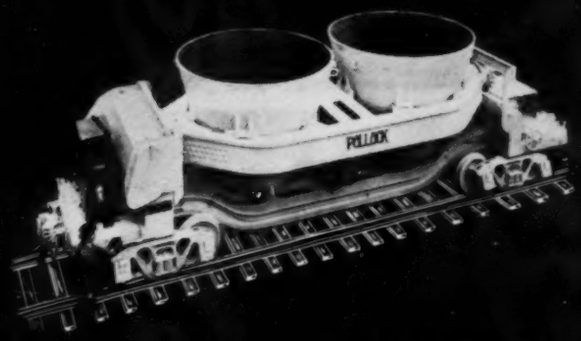
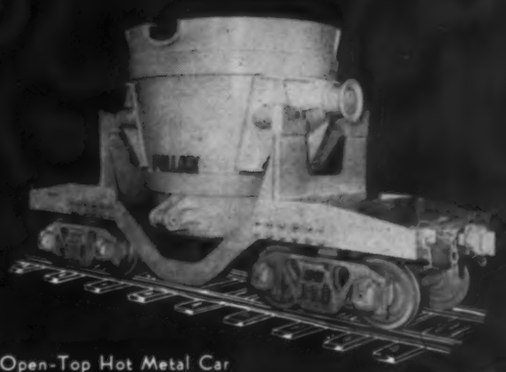
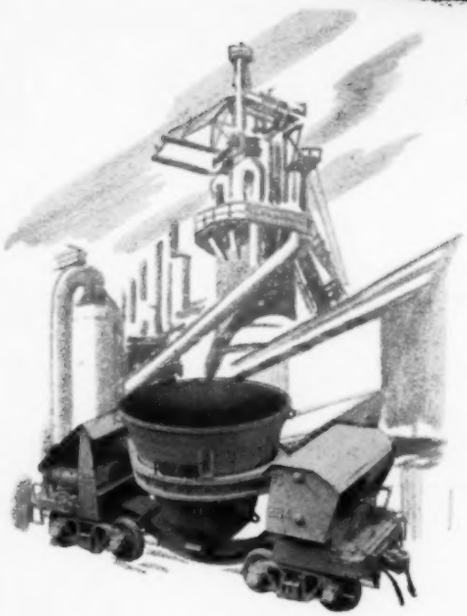


Double Pot Cinder Car



Open-Top Hot Metal Car



POLLOCK hot metal cars are equipped with demountable ladles, standard or "tailor-made" to meet your individual needs—in any capacity up to 100 tons—and these can be made even larger, depending on railroad clearances. The car bodies are of welded steel construction, either all-welded in one piece, or with end and side frames bolted together to save space in shipping. Both Kling and Open-Top types can be supplied for long pouring or short pouring.

POLLOCK cinder cars, made for air, steam, or electric operation, are sturdily built of all-rolled welded steel construction, with pots of capacities up to 400 cubic feet each. Operating equipment can be arranged to dump from either side, and trucks have A. A. R. standard wheels, axles, bearing brasses and springs. Special end-thrust bearings or roller bearings of your choice can be provided.

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In This Issue

Developments in D-C Drives for Hot Strip Mill Runout Tables and Coilers — By H. E. Larson, Steel Mill Division, General Electric Co., Schenectady, N. Y. 55

Viscosity Control of Fuel for Open Hearths — By Harvey Krouse, Fischer & Porter Co., Pittsburgh, Pa. 78

Spray Lubrication of Open Gears — By Joseph A. Rigby, Vice President, Brooks Oil Co., Pittsburgh, Pa. 87

The Electrical Laboratory in a Steel Corporation — By W. A. Black, Chief Electrical Engineer, Steel and Tubes Division, Republic Steel Corp., Cleveland, Ohio 95

Hydro-Electric Controls for Three-High Mills and Tables — By R. J. Simes, Assistant Superintendent, Mechanical Maintenance, Lukens Steel Co., Coatesville, Pa. 106

Open Hearth Dust Control — By Stephen Vajda, Staff Engineer — Steelmaking, Jones & Laughlin Steel Corp., Pittsburgh, Pa. 111

Remote Control of an Ingot Buggy with Three Motions — By K. S. Kuka, Superintendent, Electrical Engineering and Construction, Tata Iron & Steel Co., Ltd., Jamshedpur, India 121

Calculations on Carbon Hearths for Blast Furnaces — By E. W. Voice, British Iron and Steel Research Association, England 125

South Africa Expands Steel Production 135

Date-line Diary 141

Industry News 145

Personnel News 161

Equipment News 173

Index to Advertisers 189

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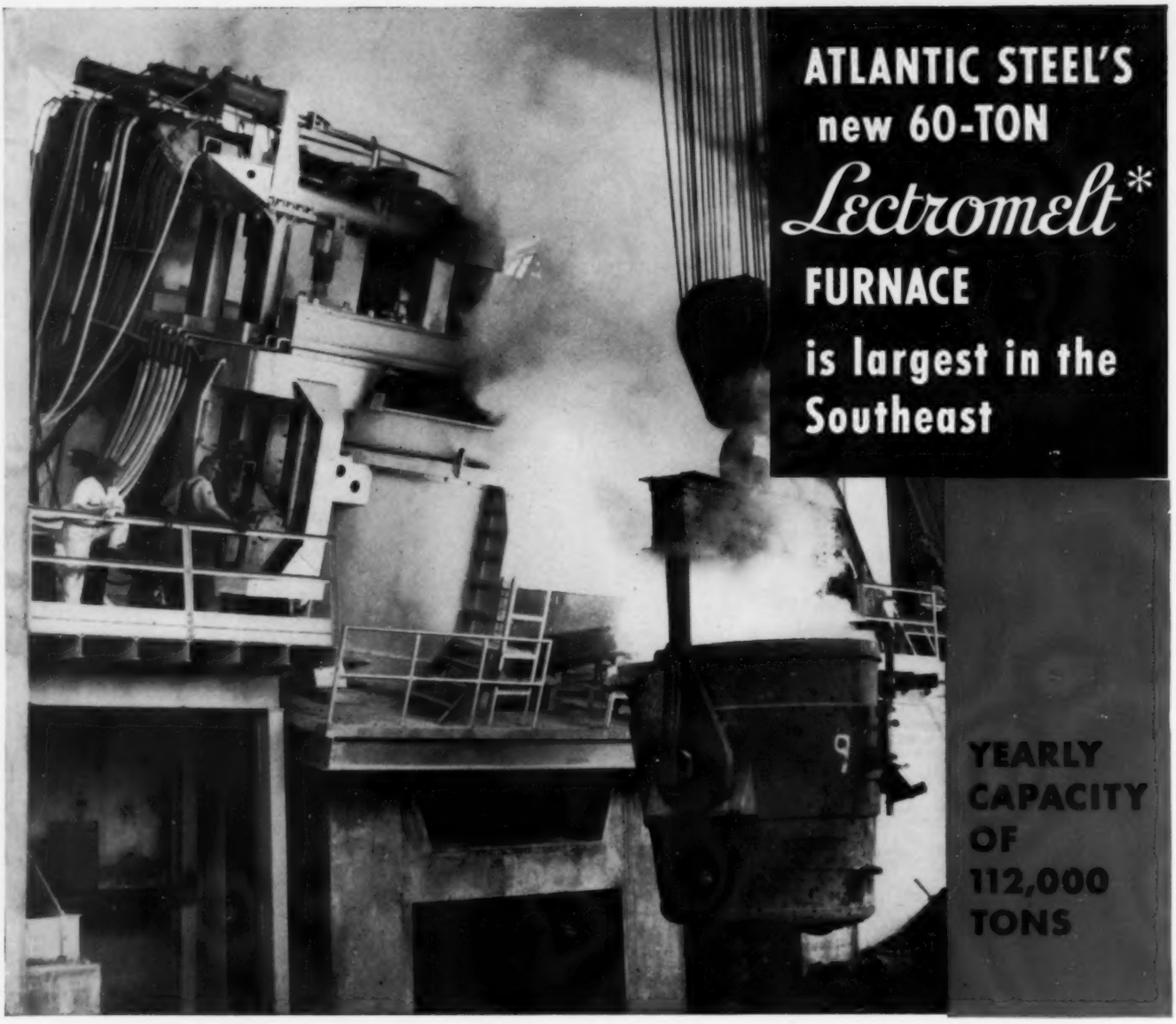

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

Developments in D-C Drives

FOR HOT STRIP MILL RUNOUT TABLES AND COILERS

By H. E. LARSON
Steel Mill Div.
General Electric Co.
Schenectady, N. Y.

. . . . it is extremely important to give attention to the small factors which improve runout table and coiler performance and reliability . . . .

▲ DIRECT-current drives for hot strip mill runout tables and coilers, instead of alternating-current, adjustable frequency drives, were first seriously considered in 1936 and first installed in 1937 on three hot strip mills. In his paper "Direct-Current Drives for Runout Tables and Coilers," 1938 Proceedings AISE, p 186, Mr. L. A. Umansky analyzed the apparent advantages of d-c drives which led to the initial installations. Since then 46 hot strip mills listed in Table I are using or will use direct-current drives for runout tables or coilers, or both.

Considerable operating experience has been gained since the initial installations were made. The performance and flexibility of the drives, and especially the low maintenance costs of the d-c mill type motors has more than justified the change to d-c drives. Mr. I. N. Tull in his paper "D-C Drives on Runout Tables and Coilers," 1949 Proceedings AISE, p 662, described the favorable experience with d-c drives on the tables and coilers of the Republic Steel Corp.'s 98-in. hot strip mill at Cleveland after eleven years of operation. Mr. Tull concluded that "— we would do the electrical job today the same way although we would provide better protection against water and shifting alignment between motors and rollers."

It is the purpose of this paper to expand the thought of Mr. Tull's conclusion — namely, improvement comes with experience. Experience during fourteen years with many hot strip mills has completely established the superiority and advantages of d-c drives. A few mills, one of which is shown in Figure 1, have even replaced a-c adjustable frequency drives with d-c drives. Some lessons have been learned from the initial installations, particularly with regard to method of mounting roll motors and their protective devices. The factors affecting roll spacing, table speeds, speed synchronization, number of table sections, and roll motor horsepower are now more clearly appreciated. Coiler design is changing and with it the requirements that must be met by the electric equipment. Developments in the application and design of electric equipment have resulted in improved performance of tables and coilers. The purpose of this paper will be fulfilled if the facts and conclusions herein presented, based on experience, will be of some use to those planning both the mechanical design and d-c drives of future runout tables and coilers.

TRENDS IN D-C RUNOUT TABLE AND COILER DRIVES

Table I is a compilation of 46 wide hot strip mills (as reported in the AISE Proceedings) that use or will use d-c runout table and coiler drives. Almost without

Figure 1 — This runout table of an 80-in. hot strip mill is now driven by individual d-c roll motors which replaced a table driven by a-c motors.

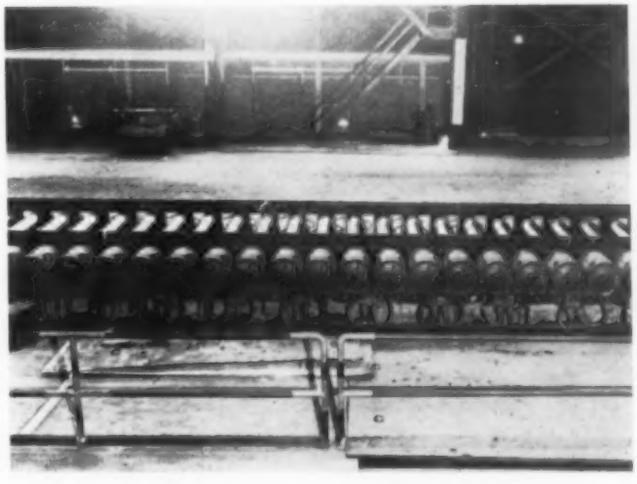


TABLE I

D-C DRIVES FOR HOT STRIP MILL RUNOUT TABLES[1] AND COILERS

Item	Purchaser	Mill width and type	Year	Maximum mill fpm	Drive	Roll Spacing, in.	No. of table sections to coilers	Coilers		No. of rolls to pilers[2]	Roll motors[3]			Gear ratio	Roll or mandrel diam, in.	Maximum fpm[18]	Mounting	Electric equipment mfgr[17]
								No.	Type		Total No.	Hp	Rpm					
1	Republic Steel Corp. Cleveland, Ohio	98 in. C	1936	2120	Tables	24	3	...	...	312	312	4.3	750	None	12	2355	4FC	GE
					Coilers	....	....	2	SDED	...	14	25.0	700	None	14	2570	FLC	GE
			1951		Coiler	....	....	1	CDMD	...	2	7.5	500/800	1.117	12	2250	FLC	GE
					Coiler pinch roll	–Top	.....	.....	.....	.....	1	75	515/690	2.25	36	2890	4FC	GE
					Coiler pinch roll	–Bottom	.....	.....	.....	.....	1	75	515/690	None	16	2890	4FC	GE
					Coiler	mandrel	.....	.....	.....	.....	1	425	375/900	3.0	30	2355	4FC	GE
2	Inland Steel Co. East Chicago, Ind.	44 in. C	1937	2130	Tables	18	3	...	...	370	181	7.5[15]	1750	2.5	12	2210	FLC[4]	GE
					Tables	(Over Coilers)	.....	.....	.....	.....	8	3.0	525	None	15.75	2165	4FC	GE
					Coilers	....	....	2	SDED	...	10	10.0	1200	1.515	10	2075	FLP	GE
3	Carnegie-Illinois Steel Corp. Irvin Works	80 in. C	1937	2010	Tables	18	3	...	...	408	200	7.5[15]	1750	2.7	12	2040	FLC2F	GE
					Tables	(Over Coilers)	.....	.....	.....	.....	8	3.0	525	None	14.7	2025	4FC	GE
					Coilers	....	....	3	SDED	...	20	20.0	1200	1.58	11	2190	FLP	GE
4	Youngstown Sheet and Tube Co. Indiana Harbor Works	54 in. C	1939	2060	Tables	36	3	...	...	152	144	4.0	750	None	12	2355	FLC2F	GE
					Tables	(Over Coilers)	.....	.....	.....	.....	8	3.0	525	None	15.5	2130	4FC	GE
					Coilers	....	....	2	SDED	...	10	15.0	1200	1.44	10	2180	FLP	GE
5	Wheeling Steel Corp. Steubenville, Ohio	66 in. C	1939	1940	Tables	36	2	...	...	139	131	4.0	750	None	12	2355	FLC2F	GE
					Tables	(Over Coiler)	.....	.....	.....	.....	8	3.0	525	None	12	1650[5]	4FC	GE
					Coilers	....	....	2	SDED	...	10	15.0	1200	1.515	10	2075	FLP	GE
6	Weirton Steel Co. Weirton, W. Va.	66 in. C	1939 and 1945[6]	1620	Tables	18 & 24	3	...	...	160	158	3.0	700	None	10	1835	4FC	GE
					Coilers	....	....	2	SDED	...	14	20.0	575	None	14	2110	FLC	GE
7	Amtorg Trading Co. Russia	.....	1940?	.....	Tables	....	....	...	...	...	....	....	...	.....	....	....	....	West.
					Coilers	....	....	...	...	...	....	....	...	.....	....	....	....	West.
8	Aluminum Co. of America Alcoa, Tenn.	SC	1940	.....	Tables	....	....	...	...	...	....	....	...	.....	....	....	....	Reliance
9	Aluminum Co. of America McCook, Ill.	SC	1942	.....	Tables	— A-c Driven		...	...	...	....	....	...	.....	....	....	....	Reliance
10	Kaiser Aluminum and Chemical Corp. Trentwood, Wash.	SC	1942	.....	Tables	....	....	...	...	...	....	....	...	None	....	....	4FC	West.
					Coilers	....	....	1	...	...	....	....	...	.....	....	....	....	West.
					Coilers	....	....	2	CDMU	...	....	....	...	.....	....	....	....	Clark-CW
11	Geneva Steel Co. Provo, Utah	132 in. SC	1942	2350	Tables	....	4	...	...	151	151	11.25	700	None	12	2200	FLC2F	West.
					Coilers	....	....	2	SDED	...	10	33	1200	1.4	10	2240	4FC	West.
12	Ford Motor Co. Detroit, Mich.	66 in. C	1942 1950	1650	Tables	30	4	...	...	141	65	5.0	575	None	10	1505	4FC	GE
					Tables	15	....	...	....	...	72	7.5[15]	1150	1.72[16]	10	1700	4FC[16]	West.
					Coilers	....	....	2	CDMD	...	8.0	30.0	690	.....	10	....	FLC	West.
					Coiler pinch rolls	–Top	.....	.....	.....	.....	2	75	850/1275	5.0	36	2400	4FC	West.
					Coiler pinch rolls	–Bottom	.....	.....	.....	.....	2	75	850/1275	3.0	22	2450	4FC	West.
					Coiler	mandrels	.....	.....	.....	.....	2	200	575/1150	4.45	28	1890	4FC	West.
13	National Steel Co. of Brazil Volta Redonda, Brazil	50 in. SC	1942	1488[7]	Tables	36	2	...	...	108	108	4.0[8]	750	None	12	2355	FLC2F	GE
					Coilers	....	....	1	SDEU	A-C motors		....	...	.....	....	....	....	Reliance
14	Steel Co. of Canada Hamilton, Ontario, Canada	56 in. SC	1944	2062	Tables	30	2	...	....	169	161	4	750	None	12[9]	2355	FLC2F	GE-CGE
					Tables	(Over	coilers)	.....	.....	.....	8	3	475/750	None	15.5	3040	4FC	GE-CGE
					Coiler	....	....	2	SDED	...	10	15	1200	1.44	10	2185	FLP	GE-CGE

TABLE I — Continued

D-C DRIVES FOR HOT STRIP MILL RUNOUT TABLES[1] AND COILERS

Item	Purchaser	Mill width and type	Year	Maximum mill fpm	Drive	Roll Spacing, in.	No. of table sections to coilers	Coilers		No. of rolls to pilers[2]	Roll motors[3]			Gear ratio	Roll or mandrel diam, in.	Maximum fpm[18]	Mounting	Electric equipment mfgr[17]
								No.	Type		Total No.	Hp	Rpm					
15	Republic Steel Corp. Youngstown, Ohio	48 in. SC	1945	1834	Tables Coiler Coiler p inch roll Coiler mandrel	24	2	... 1	... CDMU	45 ...	45 2 2 1	3 3 50 135	700 700 550 400/1200	None 1:1 None 3.09	10 11 12.75 27.0	1835 2015 1835 2750	4FC FLP 4FC 4FC	GE GE GE GE
16	Aluminum Co. of America Davenport, Iowa	80 in. SC	1946	.....	Tables Coilers	36	4 1	... ...	... ...	... ...	119 1	1.6 250	360 575/1150	None	12	1130 1000	F 4FC	Reliance Reliance
17	Bethlehem Steel Co. Sparrows Point, Md.	68 in. C	1946	2120	Tables Coilers	18	3 2	... SDED	... ...	445 ...	445 10	4 20	750 1200	None 1.4	10 10	1965 2290	FLC FLP	West. West.
18	Carnegie-Illinois Steel Corp. Gary Sheet and Tin Division	80 in. C	1935 1946	2000	Tables Coilers Coiler p inch rolls Coiler mandrels	18	4 3	... CDMD	... ...	263[10] ...	263[10] 12 3 3	4 40 200 350	800 690 850/1150 575/1150	None	12	2515	4FC FLP 4FC 4FC	GE Reliance Reliance Reliance
19	Crucible Steel Co. Midland, Pa.	66 in. R	1946	1200	Tables Coiler Coiler p inch rolls Coiler mandrel	24	3 1	... CDMU	... ...	114 ...	114 2 2 1	3 10 65 150	575 550/650 435/500 300/800	None 1.117 None 3.84	10 11 12.25 30	1508 1680 1605 1638	4FC FLP 4FC 4FC	GE ... GE ...
20	Tennessee Coal, Iron and R. R. Co. Fairfield, Ala.	48 in. SC	1937 1946	1930	Tables Coilers Coiler p inch rolls Coiler mandrels	.....	... 3	A-C driven CDMD	....	....	..... A-C coiler roll 3 3	..... motors 100 100	..... 600/1200 600/1200	....	....	....	.... 4FC 4FC	Reliance Reliance Reliance Reliance
21	A.R.B.E.D. Luxembourg	66 in. R	1947	1200	Tables Tables Coiler Coiler p inch roll Coiler p inch roll Coiler mandrel	24 (mill to shear)	3 1 – Top –Bottom	... CDMD	... ...	189 ...	178 11 2 1 1 1	2¼ 4 5 75 75 200	400/560 350/475 375/525 250/350 250/350 225/675	None None 1.117 2.24 None 3.84	10 12 12 36 16 30	1468 1492 1478 1475 1468 1380	4FC 4FC FLP 4FC 4FC 4FC	GE ... ... GE ...
22	Aluminum Co. of Canada Brazil	84 in. R	1947	.....	Tables Coiler	.....	.....	Group D-C drives through line shafts		.....	.....	.....	.....	.....	.....	.....	.....	West.
23	A. M. Byers Ambridge, Pa.	38 in. R	1947	.....	Tables Coiler	.....	.....	Group D-C drives through line shafts		.....	.....	.....	.....	.....	.....	.....	.....	West.
24	Companhia Siderurgica Belgo Brazil	40 in. R	1947	.....	Tables Coiler	.....	.....	Group D-C drives through line shafts 1	...	...	 1	 50	..... 550/1100	....	....	....	..... 4FC	West. West.
25	Denan Et D'Anzin France	66 in. C	1947	1800	Tables Coilers	....	3 2	... CDMD	... ...	... ...	273 10	3 5	750 725/1215	None 1.117	10 12	1965 3410	4FC FLC	West. West.
26	Newport Rolling Mill Co. Newport, Ky.	60 in. R	1947	1256	Tables Coilers	.....	.....	Group D-C drives through line shafts 1	...	...	 1	 150	..... 460/1150	....	 30	....	..... 4FC	West. West.
27	South African Iron and Steel Industrial Corp. Ltd.—South Africa	56 in. SC	1947	2060	Tables Coilers Coiler p inch rolls Coiler p inch rolls	....	3 2 –Top –Bottom	... SDED	... ...	... ...	287 10 2 2	4 20 35 35	750 1200 575/1200 575/1200	None 1.3	12 10	2355 2430	FLC FLC 4FC 4FC	West. West. West. West.
28	Inland Steel Co. East Chicago, Ind.	76 in. C	1931 1947	1525	Tables Coiler	.....	 2	A-C SDED	....	....	 10	 15	 975	..... 1.365	 10	1600 1870	..... FLP	GE ...

TABLE I — Continued

D-C DRIVES FOR HOT STRIP MILL RUNOUT TABLES[1] AND COILERS

Item	Purchaser	Mill width and type	Year	Maximum mill fpm	Drive	Roll Spacing, in.	No. of table sections to coilers	Coilers		No. of rolls to pilers[2]	Roll motors[3]			Gear ratio	Roll or mandrel diam, in.	Maximum fpm[18]	Mounting	Electric equipment mfgr[17]
								No.	Type		Total No.	Hp	Rpm					
29	Kaiser Co. Fontana, Calif.	86 in. SC	1948	2050	Tables Coiler Coiler p Coiler p Coiler	36 .... inch roll inch roll mandrel	3 .... –Top –Bottom	... 1	... CDMD	134	134 2 1 1 1	4 7½ 75 75 300	750 700/1000 450/690 450/690 300/900	None 1.117 2.24 None 2.46	12 12 36 16 30	2355 2820 2910 2895 2870	4FC FLP 4FC 4FC 4FC	GE GE GE GE GE
30	McLouth Steel Corp. Trenton, Mich.	42 in. R	1948	2045	Tables Coiler Coiler p Coiler	24 .... inch roll mandrel	3	... 1	... MD	... ...	179 A-C c 1 1	3 oiler roll 50 250	750 motors 550/850 300/900	None 3.38 2.0	12 .... 36 24	2355 .... 2370 2830	FLC 4FC 4FC	West. West. West. West.
31	Austrian Iron and Steel..... Linz, Austria	66 in. C	1949	2200	Tables Coilers Coiler p Coiler p	.... inch roll inch roll	3 .... –Top –Bottom	... 1	... SDED	... ...	271 4 1 1	3 20 50 50	750 1200 550/1650 550/1650	None 1.3	12 10	2355 2410	FLC FLC 4FC 4FC	West. West. West. West.
32	Sollac France	80 in. C	1949	2095	Tables Coiler Coiler p Coiler p Coiler	24 .... inch roll inch roll mandrel	3 .... –Top –Bottom	... 2	... CDMD	... ...	301 4 2 2 2	4.3 5 75 75 300	750 725 515/725 515/725 300/900	None 1.117 2.25 None 2.46	12 12 36 16 30	2355 2020 3040 3035 2870	4FC FLP 4FC 4FC 4FC	West. West. West. West. West.
33	Fagersta Bruks Fagersta, Sweden	29.5 in. R	1949	1200	Tables Coiler Coiler p	.... inch roll	....	... 1	A-C driv CDMU	en	.... 1 1	.... 22 75	.... 1170/1450 515/1300	.... 3.57 5.0	.... 12.8 19.7	.... 1365 1340	.... 4FC 4FC	Siemag GE GE GE
34	Jones & Laughlin Steel Corp. Pittsburgh, Pa.	96 in. C	1936 and 1949	1980	Tables Coiler Coiler p Coiler	.... inch rolls mandrel	....	... 2	A-C driv CDMD	en	..... 10 1 2	..... A-C m 150 250	..... otors 575/1100 250/1000	..... 1.47 2.1	..... 16.0 24.0	..... 3290 3130	..... 4FC 4FC	... Reliance GE GE
35	Allegheny Ludlum Steel Corp. Brackenridge, Pa.	56 in. SC	1950	1925	Tables Tables Coilers Coiler p Coiler	18 over coil .... inch rolls Mandrels	2 ers	... . 2	... . CDMD	138	128 10 8 4 2	3 3 25[11] 100 200	750 750 700 485/1200 420/1050	None None 0.836 1.5 3.28	12 12 10 16 26	2360 2360 2190 3360 2180	4FC FLC FLP 4FC 4FC	GE GE GE GE GE
36	Armco Steel Corp. Ashland, Ky.	80 in. C	1950	2050	Tables Coiler	24 mandrel	4	... 2	... ARMCO	... ...	195 2	3 200	650 850	None	12	2045	4FC 4FC	West. West.
37	Breedband N. V. Ijmiden, Holland	56 in. SC	1950	1636[12]	Tables Coiler Coiler p Coiler p Coiler	24 .... inch roll inch roll mandrel	3	... 1	... CDMD	176	176 2 1 1 1	3.6 5 75 75 300	900 500/800 450/690 450/690 300/900	None 1.117 2.25 None 3.1	10 12 36 16 30	2360 2255 2890 2890 2360	4FC FLP 4FC 4FC 4FC	GE&MV GE&MV ..... GE ...
38	United States Steel Co. Morrisville, Pa.	80 in. C	1950	2335	Tables Tables Coilers Coiler p Coiler	18 over coil .... inch rolls mandrels	4 ers	... . 3	... . CDMD	280	272 8 15 3 3	4.4 4.4 25 200 350	825 825 700 420 375/900	None None	12 12	2595 2595	4FC FLC FLC 4FC 4FC	GE GE GE GE GE

TABLE I — Continued

D-C DRIVES FOR HOT STRIP MILL RUNOUT TABLES[1] AND COILERS

Item	Purchaser	Mill width and type	Year	Maximum mill fpm	Drive	Roll Spacing, in.	No. of table sections to coilers	Coilers		No. of rolls to pilers[2]	Roll motors[3]			Gear ratio	Roll or mandrel diam, in.	Maximum fpm[18]	Mounting	Electric equipment mfgr[17]
								No.	Type		Total No.	Hp	Rpm					
39	Detroit Steel Co. Portsmouth, Ohio	54 in. SC	1950	2000	Tables Coiler Coiler p Coiler p Coiler	36 .... inch roll inch roll mandrel	4 .... external internal	... 2 ..... and c	... CDMU ..... oil suppor	113 ... . ting roller	113 16 2 2 4	4 2/.67 50 75 75	750 600/200 550 515/875 500/1250	None None 2.0 1.1 4.15	12 15.5 32 10.5 30	2355 2440 2300 2410 2270	FLC[13] 4FC 4FC 4FC	GE GE GE GE GE
40	Empire Steel Co. Mansfield, Ohio	52 in. C	1950	1375	Tables Coilers	36 rolls	2	... 1	... 3-Roll	... ...	71 1	3 125/150	600 300/1200	None	12	1885	4FC 4FC	West. West.
41	Youngstown Sheet and Tube Co. Campbell Works	79 in. C	1951	1515	Tables Coilers	18.0	4	... .	... A-C driv en	263	52[14]	3.49	668	None	12	2100	FLC2F	GE Reliance
42	Societa Italiana Acciaterie Cornigliano Genoa, Italy	80 in. SC	1951	.....	Tables Coilers	....	3	... 2	... SDED	... ...	251 10	4 25	750 700	.....	....	....	4FC FLC	West-Marelli West.
43	Lone Star Steel Co. Daingerfield, Texas	72 in. R	1951	1770	Tables Tables Coilers Coiler p Coiler p Coiler	29 29 .... inch roll inch roll mandrel	2 .... –Top –Bottom	... ... 1	... . CDMU	1	74 95 2 1 1 1	4 3 10 75 75 350	575 690 ... 515/600 515/600 300/900	None None ..... None None	12 10 10 12.75 12.75 30	1808 1808 .... 2005 2005	4FC 4FC FLC 4FC 4FC 4FC	West. West. West. West. West. West.
44	Granite City Steel Co. Granite City, Ill.	90 in. SC	1951	2000	Tables Coiler Coiler p Coiler	24 .... inch roll mandrel	5	... 2	... MD	80	80 2 2 2	3 5 150 250	690 575/1215 575/1150 400/1200	None	12	2200	F 4FC 4FC 4FC	Reliance Reliance Reliance Reliance
45	Jones & Laughlin Steel Corp. Otis Works—Cleveland, Ohio	77 in. C	1948	1600	Tables Coiler Coiler p Coiler	.... inch rolls mandrels	....	.... 2	A-C driv en MD	... .	.... 8 2 2	.... 40 100 200	... 690 850/1150 575/1150	....	....	....	..... 4FC 4FC 4FC	..... Reliance Reliance Reliance
46	Revere Copper and Brass, Inc. Cauton Plant, Baltimore, Md.	42 in. SC	1949	360	Tables	30	4	...	...	...	75	0.25	190	None	8	398	F	Reliance

Footnotes:

C = Continuous
SC = Semi-continuous
R = Reversing with reels
SDED = Surface driven expanding type down coiler
SDEU = Surface driven expanding type up-coiler
CDMU = Center driven mandrel type up-coiler
CDMD = Center driven mandrel type down-coiler
4FC = Four feet coupled
FLC = Flange mounted coupled (no feet)
FLP = Flange mounted-pinion on shaft
FLC2F = Flange mounted coupled-two feet
F = Floating motor

(1) Does not include reversing or intermediate tables.

(1) Including rolls over coiler and to last coiler when no piler.

(3) Includes coiler rolls or wrapper rolls. Does not include pinch roll motors except when specifically stated for Mandrel type coilers.

(4) Support added under overhung motor.

(5) Motor field weekened to obtain same roll fpm as rest of table.

(6) In 1945, 49 table rolls were added by moving coilers and eliminating piler. No. of table sections increased from 2 to 3.

(7) Arranged for addition of two future finishing stands for 2000 fpm maximum.

(8) Can be forced ventilated for 7½ hp, 750 C rise, continuous rating.

(9) Rolls are 12½-in. diam at ends and 11¾-in. diam at middle.

(10) Includes rolls to third coiler only—table rolls from third coiler to piler driven by a-c motors.

(11) Wrapper roll motors large enough to drive coiler without mandrel on light strip.

(12) Future stand will raise delivery speed from 1636 fpm to 2000 fpm.

(13) Two a-c motors inside each wrapper roll.

(14) These 52 d-c motors replace a-c motors. Table will be changed gradually from a-c to d-c motors.

(15) One 7½-hp motor drives two rolls through gears.

(16) One gear motor with two shaft extensions drives two rolls each flexibly-coupled to gear motor shaft extension.

(17) General Electric table and coiler roll motors are rated 250 volts; Westinghouse motors are rated 230 volts.

(18) Maximum fpm values are calculated on stated motor rpm ratings, gear ratios, and roll or mandrel diameters. Westinghouse motors rated 230 volts will in general operate with 250 volts applied and maximum fpm values will therefore be higher than listed.

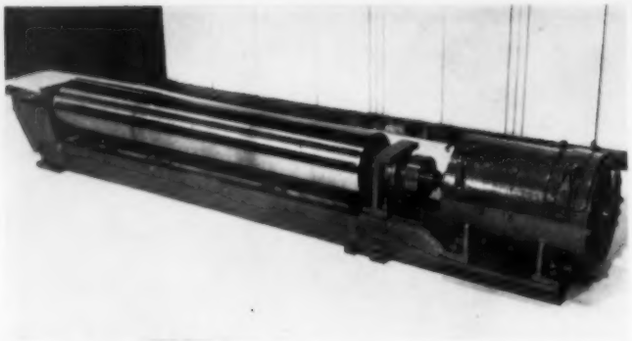


Figure 2 — Replacement roll and motor assembly for runout table of 80-in. hot strip mill shown in Figure 1.

exception, all subsequent hot strip mills since 1937 have been equipped with d-c drives on the runout table and coilers.

A study of Table I reveals certain trends that are noteworthy: (For the sake of brevity, item numbers of Table I are referred to when significant.)

a. Three mills, built before 1937, have changed runout table and coiler drives from a-c adjustable frequency to d-c (see items 5, 6, and 18) and one mill is in the process. (See item 12).

b. One mill is in the process of changing runout table drives only from a-c adjustable frequency to d-c. (See item 41).

c. One mill has changed coiler drives only from a-c adjustable frequency to d-c. (See item 28).

d. Three mills have added d-c driven mandrels and pinch rolls to two existing coilers using existing a-c driven coiler rolls. (See items 20, 34 and 45).

e. Table roll spacing on the new mills tends to be 18 in. or less.

f. The number of table sections to the coilers on the newer mills has increased from three to four, (see items 12, 18, 36, 38 and 41) except on reversing hot strip mills which generally use three table sections.

g. Table rolls of most mills are 12 in. in diameter, but a few mills have table rolls 10 in. in diameter.

h. The great majority of mills use one motor with four feet, flexibly coupled to one table roll without gears.

i. The number of coilers on several high production mills has increased from two to three. (Items 1, 3, 18, 20 and 38).

j. Coilers of the later mills are almost all of the center driven mandrel type.

TIME TESTED METHODS OF DRIVING TABLE ROLLS AND MOUNTING TABLE ROLL MOTORS

Table rolls warp from heating and cooling cycles and from physical abuse. It is not uncommon practice to enlist the aid of magnets or slabs weighing as much as five tons when clearing the table of cobbled strip. Sometimes, the head end of the strip finds its way between a roll and an apron. Both aprons and rolls suffer when the strip is hitched to a crane and removed. As a result, rolls frequently are bowed and the roll shaft extensions wobble.

Several of the earlier mills employed two rolls geared to one motor which carried the pinion meshing with the roll gears on its own bearings. The motors were also flange mounted. This type of mounting has generally been abandoned because:

a. Rolls must be changed in pairs when trouble occurs on one roll.

b. The flange mounted overhung motor driving through gears without motor body support vibrated severely, contributing to motor bearing troubles.

c. The gear lubricant found its way into the motor bearing.

One of the mills using this type of table construction has found it necessary to extend the motors to allow more room for separate pinion bearings. The motor is flexibly coupled to this pinion shaft. Saddles have been added to relieve the flange on the mounting adapter from carrying the entire overhung weight of the motor.

The time tested method of driving table rolls and mounting motors, employed by the majority of mills, is to flexibly couple the motor to the roll shaft extension and provide four feet on the motor (see Figure 2). On at least the Republic mill, described by Mr. Tull, has this method been modified to interpose a spindle and two flexible couplings between the roll shaft and the motor. The motor should be coupled to the roll on the back side of the table, opposite the mill operating side.

A few mills still employ a flange mounted motor with two motor feet, the motor being flexibly coupled to the roll shaft extension. Flange mounting of the motors reduces accessibility to the coupling, and makes it necessary to remove the motor more frequently when working on roll bearings than in the case of four foot-mounted motors. Flange mounting, while fixing one end of the motor with respect to the roll bearing, does not eliminate the need for maintaining the two motor feet supporting the motor body in strict alignment with the tables.

One mill now changing tables to d-c drive will use a gear-motor with two shaft extensions, each flexibly coupled to a roll.

Flexible couplings between rolls and roll motors have usually been of the "rubber ball" type. The advantage of this type of coupling seems to be that it "fails safe." In case of severe roll shaft extension wobble or misalignment due to shifting of roll or motors, the rubber balls simply wear out and uncouple the motor. One mill has found it necessary to replace about two couplings per week and all couplings once in approximately two years.

There is another type of mounting and drive known as "floating motor drive" described by Mr. A. M. MacCutcheon in his paper, "Floating Motor Drive for Roller Tables," 1941 Proceedings AISE, p 360. While this drive has considerable appeal, it requires that the weight of the motor be completely overhung and carried by one roll bearing. As rolls warp, the motors wobble. Vibration and bearing loadings may become very severe at speeds as high as 750 to 800 rpm. Table I shows that "floating motor drive" has been used mainly on the runout tables of hot strip mills delivering at the relatively low speeds of 1000 fpm or below.

TABLE ROLL SPACING AND ITS EFFECT ON TABLE PERFORMANCE AND DRIVE COST

On the newest high production continuous mills, the table roll spacing (center distance) of individually driven rolls has been as low as 18 in. The point has now been reached where the present design of individual roll motors must be reduced in diameter for roll spacings less than 18 in. The motor designers are now prepared to build totally-enclosed non-ventilated mill-type MDY motors rated 4-hp continuous, 750-rpm, with the diameter so reduced as to permit table rolls to be mounted on 14½ in. centers.

Table I shows actual roll spacings varying from 18 to 36 in. In view of this rather wide divergence, it should be of interest to recognize at least some of the factors that influence the choice of roll spacing.

One of the most important factors affecting the choice of roll spacing is the omission of or use of aprons between rolls. While aprons do the job for which they are designed, they also cause troubles. Either through warping or abuse from magnets or slabs laid on the table, the aprons rub on the rolls and even lock them. Motors are protected against these conditions by protective control panels, but a roll is lost and maintenance work is constantly required. Strip has many times found its way between the aprons and the rolls. Mills with 36-in. roll spacing and aprons have found short sheared pieces difficult to transport over the table. Thin strip tends to drag on the aprons, preventing the rolls from propelling the strip. When strip piles up on a table with wide roll spacing, the rolls are of little assistance in clearing the table because a large percentage of the strip is resting on the aprons and not on the rolls. For these reasons, many companies have found aprons so objectionable that they have eliminated them from new mills.

When no aprons are used, table roll spacing must, of course, be very close. One high production mill is operating with good results using 12-in. diam rolls on 18-in. centers without aprons. Another 80-in. continuous mill table is being built on the same basis. Still another continuous mill being revamped will use 10-in. rolls on 15-in. centers without aprons.

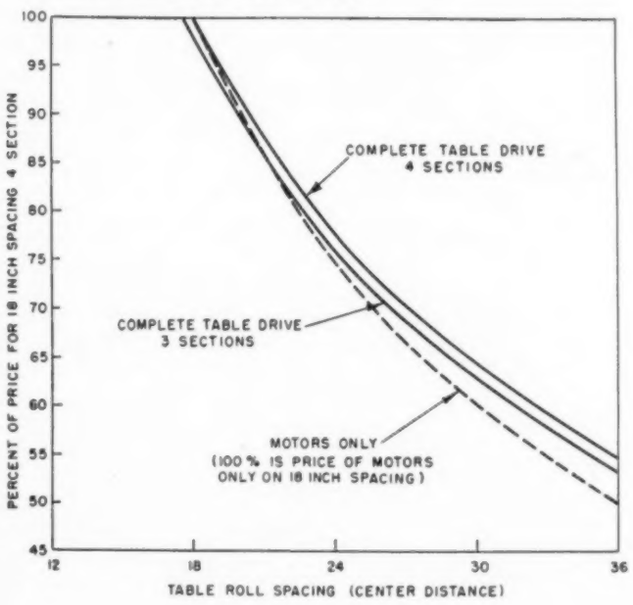
Another factor enters in when a mill is designed to roll light plate as well as strip. When the plate is heavier than can be sheared and handled in the piler, the table must be stopped for each plate and the plate transferred to another table. Because transfer fingers must be located between rolls, such mills may be forced to increase table roll spacing and use aprons on at least one section. It is important to note here that for this frequent starting and stopping service, the d-c table drive is far superior to the a-c adjustable frequency drive as demonstrated by actual practice because of the lower losses and reduced heating in the individual d-c table roll motors.

Mills are in operation and are still being built that use aprons. What then governs the choice of roll spacing if the operating steel company elects to use aprons? Some of these factors are:

1. The minimum thickness of the strip to be rolled. Thin strip points to closer roll spacing.
2. The minimum length of sheared pieces. Pieces as short as 15 ft cannot be easily handled on a table with roll spacing as great as 36 in.
3. The hampering of production rates upon loss of rolls and the delay occurring when clearing tables in cases of trouble.

It is, of course, the cost of the mechanical and electrical equipment that these factors are balanced against. It is sometimes well for engineers to remember, when planning a runout table, that "the first cost is soon liquidated by the accountants — the performance or lack of it is with you always." In order to give some idea of the relative cost of the electric equipment for a given length of table with various roll spacings, the curves of Figure 3 have been prepared.

Figure 3 — Percentage price comparison of roll drives for a 360-ft runout table. Standard of comparison or 100 per cent is 4-section table with 18-in. roll spacing. Roll motors are 4 hp, 750 rpm.



The curves of Figure 3 are based on a table 360 ft long from the last mill stand to the end of the coilers. The curves are based on prices calculated for roll motors, motor protective devices, motor-generator sets with exciters, and complete control with desk for four roll spacings — 18, 24, 30 and 36-in. No 6900 volt switchgear is included for the motor driving the motor-generator set. The price for the complete electrical system using 18-in. roll spacing and four 90-foot table sections is considered to be the 100 per cent figure or standard of comparison. The dotted curve shows the price comparison between roll spacing and table roll motors only, assuming them to comprise the entire drive cost. It is interesting to note that four table sections can be had for almost the same price as three table sections.

Table roll spacing also affects the weight of metal that each roll must accelerate, propel, and decelerate. Actual test data shows that the torque required to propel strip at constant speed is only a very small fraction of the torque required for acceleration and decleration of strip and roll inertia. *The principal job of a table roll motor* (barring abnormal conditions) *is to accelerate and decelerate the inertia of the roll and that portion of the strip that the roll carries.*

TABLE II

Comparison of Inertia Values of Runout Table Rolls Carrying Strip and Plate from 80-In. Hot Strip Mill for Various Roll Spacings

Roll spacing, in.	WK^2 (lb-ft²) 0.125 × 72-in. strip			Strip WK^2, per cent of total	WK^2 (lb-ft²) 0.750 × 72-in. plate			Plate WK^2, per cent of total
	Rolls and motor	Strip	Total		Rolls and motor	Plate	Total	
Part A — Hollow Rolls								
14.5	196.0	9.1	205.1	4.4	196.0	55.8	251.8	22.2
18.0	196.0	11.3	207.3	5.5	196.0	68.0	264.0	25.7
24.0	196.0	15.1	211.1	7.2	196.0	90.8	286.8	31.6
30.0	196.0	18.9	214.9	8.8	196.0	113.3	309.3	36.7
36.0	196.0	22.7	218.7	10.4	196.0	136.2	332.2	41.0
Part B — Solid Rolls								
14.5	341.0	9.1	350.1	2.6	341.0	55.8	396.8	14.1
18.0	341.0	11.3	352.3	3.2	341.0	68.0	409.0	16.6
24.0	341.0	15.1	356.1	4.2	341.0	90.8	431.8	21.1
30.0	341.0	18.9	359.9	5.2	341.0	113.3	454.3	25.0
36.0	341.0	22.7	363.7	6.2	341.0	136.2	477.2	28.6

A hot strip mill normally delivers strip to the runout table at a maximum thickness of, say, 0.125 in. It may also roll plate during wartime which may be, say, 0.750 in. thick. The table rolls may be hollow or solid. Table II has been prepared to show the effect on the inertia to be accelerated for various roll spacings for the above strip and plate conditions with 12 in. rolls.

The following conclusions can be drawn from Table II with regard to the effect of roll spacing on inertia for a range from 14.5 to 36 in. spacing:

1. Roll spacing has little effect on total inertia when only strip is conveyed by the table.
2. Roll spacing has a great effect on total inertia when plate as well as strip must be conveyed. This effect is so great as to have an important bearing on motor size.

Because the table rolls run faster than the strip, especially when the metal is in the mill, there is a slippage torque that should be taken into account when necessary to calculate motor heating. This slippage torque is in addition to bearing friction and windage torque. Assuming a coefficient of friction of 0.25, this slippage torque is:

$$\text{Slippage torque} = 0.25 \times \text{weight of metal (lb)} \times \text{roll radius (ft)}$$

Table III gives the slippage torque for various roll spacings for assumed maximum strip and plate sections.

RUNOUT TABLE SPEEDS FOR VARIOUS OPERATING CONDITIONS AND SPEED SYNCHRONIZATION WITH THE MILL

The maximum table speed should always be higher than the maximum mill speed by 10 to 15 per cent. Operating speeds of tables when coiling are always above mill speeds to obtain a stretching effect on the strip. Table IV shows speeds actually measured on one hot strip mill:

When coiling, the delivery speeds of a mill with a maximum delivery speed of 2000 fpm usually varies from 800 to 1750 fpm. At the higher speeds, many mills

TABLE III

Torque* for Various Roll Spacings Required to Slip Rolls on Metal for 80-In. Hot Strip Mill Runout Table

(Motor assumed at 4-hp, 750-rpm — rated torque — 28 lb-ft. Roll diameter — 12 in.)

Roll spacing, in.	0.125 × 72-in. Strip			0.750 × 72-in. Plate		
	Lb wt per roll	Friction torque, lb-ft	Per cent rated motor torque	Lb wt per roll	Friction torque, lb-ft	Per cent rated motor torque
14.5	36.5	4.6	16.4	219	27.4	97.8
18.0	45.3	5.7	20.3	272	34.0	121.5
24.0	60.5	7.6	27.1	363	45.4	162.0
30.0	75.7	9.5	33.9	453	56.8	203.0
36.0	90.8	11.3	40.3	545	68.2	243.0

*Does not include bearing friction or windage.

slow down the head end of the strip before entering the coiler. One mill with three table sections slows down Sections No. 2 and No. 3; another mill with four table sections actually stops table section No. 4, using it as a friction brake to slow down the strip before it enters the coiler.

When shearing the strip into sheets, mill delivery speeds are always lower than when coiling. The maximum speed of the table is usually limited to about 1300 fpm by the buckling of the sheets when striking the piler bumpers. Minimum speeds for short pieces may be as low as 500 fpm. When transporting sheared sheets over the table, the table speed is higher than mill delivery speed to obtain space between sheets. Space is necessary to allow a time interval for proper piling and varies somewhat with the length of the sheets.

Synchronized control of table speed with mill speed is easily obtained with the newer type of rotating regulator generator controls. The function of voltage regulation against some standard is always included, as well as current limit control of acceleration and deceleration. The standard of voltage comparison can be the voltage drop across the potentiometer dial of a small rheostat, supplied from a constant voltage circuit. It can also be the voltage drop across this same rheostat except that its potentiometer dial is energized from a small pilot generator driven by the last mill stand, thus providing synchronized control of table speed to mill speed. Once preset, this *ratio* will be held for the usual variations in mill delivery speed, without attention from the operator who can change the *ratio* at will.

Several recent table installations have been made providing both *manual control* and *synchronized control* of table speed. The value of synchronized control seems to be greatest when coiling strip and least when piling sheared sheets. Since the only complication introduced by synchronized control is the pilot generator that must be mounted and driven from, say, each of the last two finishing stands, the use of synchronized control seems justified.

A comment on methods of measuring and indicating table speed might be relevant. A tachometer generator mounted on one table roll motor of each section is the only direct way of measuring roll fpm and even this method assumes a fixed roll diameter. But this method introduces complications because a few table motors carrying tachometer generators differ mechanically from the rest and, therefore, the number of spares that must be carried is increased. Since table roll motors operate at constant field strength through an operating speed range, say, of not more than 4 to 1, it has been found sufficiently accurate to assume table fpm proportional to applied voltage and simply calibrate the generator voltmeter in fpm. Tests show that the armature current taken by a roll motor running at constant speed is only a small fraction of its rated current and, therefore, the IR speed drop of the motor is negligible.

SELECTION OF RUNOUT TABLE MOTOR RATINGS AND SOME TEST DATA

Practically all of the table roll motors listed in Table I are rated totally-enclosed non-ventilated, 75 C rise continuous with Class B insulation, 250 volts. The table

TABLE IV

Actual Measured Table and Coiler Roll Speeds — Fpm

Mill speed	Table sections			Coiler rolls, no load
	Section A_1	Section A_2	Section A_3	
1200	1500	1400	1300	2000
1350	1500	1500	1400	2250
1400	1650	1600	1400	2050

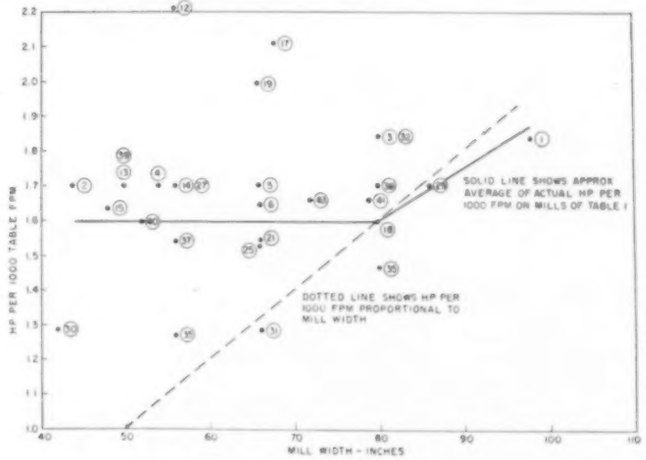
motors of item 13 — Table I were arranged for future forced ventilation, if found necessary, because the duty cycle called for possible future starting and stopping for every piece. This type of operation is also encountered when rolling heavy plates that must be stopped and transferred to another table or on a reversing hot strip mill when the first table section reverses with the mill for one or two passes. Barring these special conditions, actual tests show that motor temperature rise in usual runout table service is ridiculously low, such as 10 to 20 C. This points to low friction losses as well as infrequent starting and stopping. It also suggests that the size of a runout table roll motor should be determined solely by the torque required to accelerate and decelerate the motor, roll and metal inertia at the desired rate. This conclusion is borne out by the test data of Table V.

The principal conclusions to be drawn from Table V are:

1. Friction and windage losses, even with two rolls geared to one motor, are very small. One hp for an 80-in. mill and ½ hp for a 56-in. mill, both at 2300 fpm, would seem conservative figures to use.
2. The presence of strip on the rolls causes some increase in friction load. This increase is due more to slip loss of the rolls running faster than the strip, than to the weight of the strip on the rolls.
3. The current peaks on the generators tend to limit the rates of acceleration and deceleration.
4. As is well known, but often disregarded, roll inertia and accelerating rate have everything to do with performance of runout table drives.

There is some evidence to indicate table roll motors have been selected too conservatively in the past. The

Figure 4 — Hp per 1000 table fpm (a factor proportional to motor torque), for the table roll motors of the mills of Table I plotted against mill width.


HP PER 1000 TABLE FPM
MILL WIDTH - INCHES
SOLID LINE SHOWS APPROX. AVERAGE OF ACTUAL HP PER 1000 FPM ON MILLS OF TABLE I
DOTTED LINE SHOWS HP PER 1000 FPM PROPORTIONAL TO MILL WIDTH

low temperature rises of motors in actual operation are usually disregarded, as has been the fact that Type MDY table roll motors have a frequently repeated torque capacity of 500 per cent of rated torque. As a check on past practice, it seems reasonable to expect that a plot of the *horsepower per 1000 table fpm* (a factor proportional to torque for a given roll diameter) against mill width for the mills of Table I should show lower *horsepower per 1000 fpm* values for the narrower mills. Figure 4 shows that *horsepower per 1000 fpm* values tend to be constant at about 1.6 hp/1000 fpm rather than lower for the narrower mills.

The table motors represent the largest portion of the cost of a table drive and therefore their rating selection should be based on facts and expected table performance rather than on rough comparison with mills already in operation. An example can perhaps best illustrate the recommended method of table roll motor selection:

EXAMPLE ILLUSTRATING RECOMMENDED METHOD FOR DETERMINING ROLL MOTOR RATING

Data:

Mill — 80-in. wide delivering strip (not plate).
Roll — 12-in. diameter, hollow, WK^2 = 190 lb-ft².
Roll spacing — 18 in.
Strip WK^2 per roll — 11.3 lb-ft².
Motor coupled to roll.
Maximum table fpm = 2515 = 800 motor rpm.
Desired time to accelerate and decelerate from 2515 fpm — 8 sec.
Friction hp assumed at 1.00 hp at 800 motor rpm.

TABLE V

Test Data Showing Power Input to One Table Roll Motor of a Table Section and Power Output of Generator Supplying Same Section

	Mill-item 2 of Table I	Mill-item 4 of Table I	Mill-item 18 of Table I
1. Roll number	No. 59	No. 60	No. 88
2. Roll spacing — in.	18	36	18
3. Motor hp rating — 250 v	7.5	4.0	4.0
4. Motor rpm rating	1750	750	800
5. Corresponding table fpm	2210	2355	2515
6. Motor full load amp	25.5	14.0	14.0
7. No. of rolls per motor	2	1	1
8. Gear ratio — motor to roll	2.5	None	None
9. Roll diam — in.	12	12	12
10. Roll length — in.	44	64.5	80
11. Roll cross-section	Solid	Solid	Hollow
12. Roll WK^2 — lb-ft² — referred to motor	85	260	190
13. No. of motors per table section	38	46	67
14. Kw rating of section generator — 250 v	250	200	300
15. Rated amp of generator	1000	800	1200
16. Rated roll motor amp × No. of motors in table section	970	634	938
17. Roll friction and windage: No strip			
a. Motor voltage	184	174	158
b. Motor rpm	1288	522	506
c. Table fpm	1620	1640	1588
d. Mill fpm	1600	.....	.....
e. Motor amp	3.5	1.5	5.5
f. Watt input	644	261	870
g. Approximate hp output	0.32	0.08	0.70
h. Approximate hp per roll	0.16	0.08	0.70
i. Total generator amp	190.0	144.0	375
18. Roll friction and windage: With strip			
a. Strip thickness and width	0.062 × 36 in.	0.093 × 47.75 in.	.....
b. Motor voltage	184	164	158
c. Motor rpm	1288	504	506
d. Table fpm	1620	1585	1588
e. Mill fpm	1600	.....	.....
f. Motor amp	7.0	3.6	6.8
g. Watt input	1288	605	1075
h. Approximate hp output	1.0	0.60	0.96
i. Approximate hp output per roll	0.5	0.60	0.96
j. Increases in hp due to presence of strip	0.34	0.52	0.26
k. Total generator amp	400	200	400
19. Acceleration — No strip			
a. Maximum roll fpm	1600	1700	1790
b. Peak motor amp	39	17	45.0
c. Peak motor amp — per cent of rated	153	122	321.0
d. Peak generator amp	3000	1536	2300
e. Peak generator amp — Per cent of rated amp	300	192	192
f. Approximate accelerating time — sec	20	16.5	9.0
20. Deceleration to rest — No strip.			
a. Maximum roll fpm	1600	1700	1790
b. Peak motor amp	46	20	35.0
c. Peak motor amp — per cent of rated amp	180	143	250
d. Peak generator amp	3800	2300	1950
e. Peak generator amp — per cent of rated amp	380	288	162
f. Approximate decelerating time — sec	10	8.5	8.0

Average Torque to Accelerate the Roll and Strip:

Assume motor $WK^2 = 6$ lb-ft^2.
Assume coupling $WK^2 = 4$ lb-ft^2.
Total $WK^2 = 190 + 6 + 4 + 11.3 = 211.3$ lb-ft^2.

$$\text{Friction torque} = \frac{5250 \times \text{hp}}{\text{rpm}} = \frac{5250 \times 1.00}{800} = 6.6 \text{ lb-ft.}$$

Average accelerating torque

$$= \frac{WK^2 \text{ (lb-ft}^2) \times \text{rpm}}{308 \times t \text{ (sec)}} + \text{friction torque}$$

$$= \frac{211.3 \times 800}{308 \times 8} + 6.6 = 75.1 \text{ lb-ft.}$$

This is average accelerating torque — maximum accelerating torque may be 1.33 to 1.50 times higher. Also, torque load on a few rolls on which a cobble rests will be higher.

Determination of Motor Rated Torque and Horsepower:

Type MDY motors are designed for frequently repeated torque peaks of 500 per cent of rated torque. The maximum torque peaks occurring during acceleration may be as much as 1.50 times the average accelerating torque because the rate of acceleration is not constant. Maximum torque peaks of 500 per cent also occur on individual motors when strip is cobbled on the table or aprons lock rolls. It is suggested therefore that:

a. Motors be selected on the basis of 350 per cent of rated motor torque as average accelerating torque.
b. Generators be selected so that their maximum occasional momentary capacity equals the motor current corresponding to maximum accelerating torque obtained by multiplying the average accelerating torque by a factor of 1.33 based on experience rather than 1.43 obtained by dividing 500 by 350 per cent.

$$\text{Required rated motor torque} = \frac{75.1}{3.5} = 21.5 \text{ lb-ft}$$

Required rated hp

$$= \frac{\text{rated torque} \times \text{rpm}}{5250} = \frac{21.5 \times 800}{5250} = 3.28 \text{ hp.}$$

The nearest standard hp is 4 hp and, therefore, a 4-hp, 75 C rise continuous, Class B insulated, 800-rpm, 250-volt motor should be used. NOTE: This selection neglects RMS heating which can be done for normal runout table service. If table must start and stop for every piece, RMS heating must be checked.

Another solution to the example is possible, illustrating the use of more than 250 volts applied to the roll motor if the desired accelerating time is increased from 8 to 10 seconds. This solution uses a 3-hp, 750 rpm, 250-volt table motor already developed.

Average Torque to Accelerate the Roll:

$$\text{Average torque} = \frac{211.3 \times 800}{308 \times 10} + 6.6 = 61.4 \text{ lb-ft}$$

Determination of Motor Rated Torque and Horsepower:

$$\text{Required rated torque} = \frac{61.4}{3.5} = 17.6 \text{ lb-ft}$$

$$\text{Required rated hp} = \frac{17.6 \times 800}{5250} = 2.68 \text{ hp}$$

Now, the 3-hp, 750-rpm, 240-volt motor can be operated at $\frac{800}{750} \times 250 = 267$ volt, and can then be rated $\frac{267}{250} \times 3 = 3.20$ hp, 800 rpm. Its torque rating is $\frac{5250 \times 3.2}{800} = 21$ lb-ft.

This motor can be used with appreciable saving in drive cost with only two seconds sacrifice in accelerating time to 2515 fpm. Type MDY table roll motors rated 250 volts can be operated at voltages not exceeding 300 volts at maximum table fpm and can be so selected.

This alternate selection of a smaller table motor made possible partly by a two second sacrifice in accelerating and decelerating time raises the question, "How fast should a table accelerate and decelerate?"

It is usually held that a table need not accelerate or decelerate faster than will cause the metal to slip on the rolls. For a coefficient of friction of 0.25, a rate of acceleration of 480 fpm/sec is the *maximum rate* that can be obtained without slippage.

All three of the mills at which tests were made (the results of which are summarized in Table V) are reasonably well satisfied with their average accelerating and declerating rates. The *average* accelerating rates vary from 80 fpm per second to 200 fpm per second. The *average* decelerating rates are more comparable, varying from 160 fpm per second to 225 fpm per second. Because acceleration and deceleration cannot be accomplished at constant rates, the *maximum rate* is higher than the *average rate* by approximately 33 per cent.

The time allowed for acceleration and deceleration is of vital importance in determining the size of each roll motor and section generator, and prospective purchasers should give this element serious thought. In the previous example, the time of 8 sec to 2515 fpm represents an *average rate* of acceleration and deceleration of 315 fpm per second, which is considerably higher than that of any of the three mills at which tests were run. However, the table motors and generators of the third mill, item 18, Table I, can decelerate at a higher rate than tested. During deceleration, peak generator amperes could have been 250 per cent rather than the tested 162 per cent, decreasing the decelerating time from 8 to 5.2 seconds or $\frac{1790}{5.2} = 345$ fpm/sec. The corresponding *maximum rate* of $1.33 \times 345 = 458$ fpm per second is still below the slippage rate. For this reason, the *average rate* of acceleration and deceleration in the previous example has been assumed at 315 fpm per second, but it does not follow that a new mill need have rates this high. Considerable saving in the cost of the table drive can be made by keeping this rate as low as possible.

NUMBER OF TABLE SECTIONS DESIRABLE AND DETERMINATION OF MOTOR-GENERATOR SET RATING

A table section is that portion of a runout table having consecutive rolls that can be started, adjusted in speed, and stopped independent of the rest of the table. One generator is required to supply the roll motors of *each* table section. As far as possible, each table section should include the same number of rolls so that the generators may be duplicates.

There is a tendency to determine the number of table sections solely by the length of the table. This is not entirely correct. It may be helpful first to investigate the factors that determine the length of the runout table. In response to the question: "How long should a runout table be?" a popular answer is: "Long enough to reach from the mill to the coilers."

There are, of course, definite factors that affect the

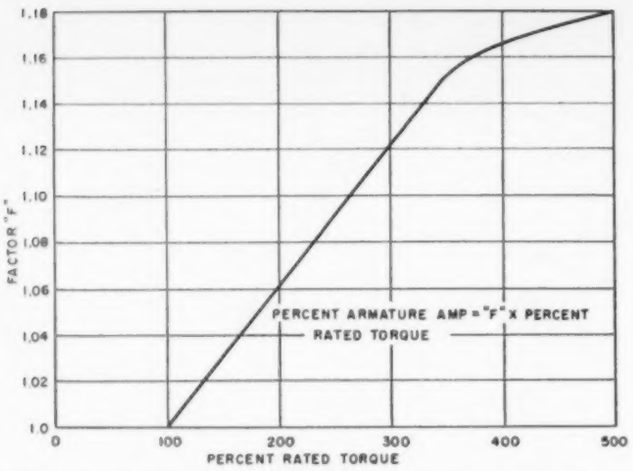


Figure 5 — Factor "F" by which per cent torque should be multiplied to obtain per cent rated armature current of type MDY runout table motors.

distance from the mill to the coilers. Some of these are:

1. Size of slab, width and length of strip.
2. Mill delivery speed.
3. Time to be allowed for water and air cooling the strip before coiling.
4. The number of slabs that must be stored on the table in case of coiler trouble, which depends on the number of slab heating furnaces and the maximum production rate of the mill.

Experience has indicated that factor No. 4 above for a high production continuous mill, especially if it has more than three slab heating furnaces, dictates the use of four table sections. Such a mill may have five or even six slabs in process and, in the event of coiler trouble, two table sections must be kept clear for receiving strip until the last slab is through the mill. One section can then be used for storage and one for feeding into the coilers. Many continuous and semi-continuous hot strip mills with three or fewer furnaces operate satisfactorily with three table sections, but could use four sections to advantage, particularly since the cost difference between three and four sections is so slight (see Figure 3). Because the first section of a reversing hot strip mill must be kept clear for reversing with the mill on one or two passes, a total of three table sections are usually used which still allows only one section for storage and one section for coiling.

When piling, the coils are not used. It is common practice to split the table between the coilers and the piler into that number of sections that permits the best use of the coiler generators.

The current rating of a generator for a given table section cannot be determined simply by multiplying the number of motors in a section by the rated current of each motor. The current taken by all the motors in a section when developing the required *maximum* torque to get the desired table performance is the real criterion. See Figure 5 for relation between motor armature current and rated torque as affected by armature reaction. It must be remembered that the *maximum* accelerating torque will be higher by about one-third during the early portion of the accelerating cycle. The current from Figure 5 for the maximum accelerating torque expressed in amperes multiplied by the number of motors should equal the maximum *occasional* momentary capacity of the generator. Experience has shown that a generator having 300 per cent maximum *occasional* momentary capacity is an expedient selection for table service. The following example illustrates the selection of a generator for a section of table for which the motors have already been selected in the previous example.

EXAMPLE ILLUSTRATING RECOMMENDED METHOD FOR DETERMINING TABLE SECTION GENERATOR RATING

Data:

Number of motors per table section — 67.
Roll motors — 4-hp, 800-rpm, 250-volts, Type MDY — 14-amp rated armature current.
Desired time to accelerate to and decelerate from 2515 fpm — 8 sec.
(See previous example for determination of roll motor rating.)

Maximum Momentary Accelerating and Decelerating Current Peaks:

$$\text{Rated motor torque} = \frac{5250 \times 4}{800} = 26.2 \text{ lb-ft}$$

$$\text{Average accelerating torque} = \frac{75.1}{26.2} \text{ lb-ft or}$$

$$\frac{75.1 \times 100}{26.2} = 287 \text{ per cent.}$$

Maximum accelerating torque = 1.33 × 287 per cent = 382 per cent.
From Figure 5, per cent motor armature current = 1.162 × 382 = 443 per cent.
Maximum occasional momentary generator amp = 67 × 14 × 4.43 = 4160 amp.

Determination of Generator Rating:

By experience and economics of design, the maximum occasional momentary generator amperes should equal 300 per cent of rating.

$$\text{Required generator rated amp} = \frac{4160}{3} = 1387 \text{ amp.}$$

Required generator kw rating = 250 × 1387 = 347 kw at 250 volts.
Since the next larger standard generator rating is 400 kw, this should be used, even though it has some extra capacity.
This generator is considerably larger than that rating obtained simply by multiplying the rated current of 67 motors by 250 volts — 67 × 14 × 250 = 235 kw.

An alternate motor rated 3-hp, 750-rpm, 250-volts (full load amperes — 10.5), operating at 267 volts, was previously selected based on increasing the accelerating time from 8 to 10 seconds. What generator should be used on this basis?

Maximum Momentary Accelerating and Decelerating Current Peaks:

$$\text{Rated motor torque} = \frac{5250 \times 3}{750} = \frac{5250 \times 3.2}{800} = 21 \text{ lb-ft}$$

Average accelerating torque

$$= 61.4 \text{ lb-ft or } \frac{61.4}{21} \times 100 = 293 \text{ per cent.}$$

Maximum accelerating torque = 1.33 × 293 per cent = 389 per cent.
From Figure 5, per cent armature current = 1.164 × 389 = 453 per cent.
Maximum occasional momentary generator amp = 67 × 10.5 × 4.53 = 3190 amp.

Determination of Generator Rating:

Required generator rated amperes $= \frac{3190}{3} = 1063$ **amp.**

Required generator kw rating —
The required generator is 267 volts times 1063 amp = 284 kw. A generator rated 300-kw, 275-volts, having a rated current of 1090 amperes should be used.
This generator is larger than that rating obtained by simply multiplying the rated current of 67 motors by 250 volts — 67 × 10.5 × 250 = 176 kw.

For those rare cases when the horsepower rating of the individual roll motors is determined by the RMS horsepower of a severe duty cycle involving starting and stopping for every piece, the kw rating of the generator must, of course, be at least equal to the continuous full load current of the roll motors of a section.

The synchronous motors driving table generators should be selected on the following basis:

Motor Hp Rating — Number of generator × kw rating of each generator × 1.5 (or 1.45 for generators larger than 300 kw).

The pull-out torque of the motor should be 225 per cent and need not be 300 per cent because the peak of accelerating amperes occurs at about 70 per cent voltage and drops off rapidly at higher values of generator voltage.

DESIGN IMPROVEMENTS MADE IN TYPE MDY TABLE MOTORS

The basic features of the Type MDY table motors are the same today as on the first motors built in 1937. These are:

1. Mill type construction — totally enclosed, non-ventilated.
2. One-piece solid roll steel frame, sealed for water tightness, with lifting lugs.
3. Large commutator and handhole covers, quickly removable.
4. Class B insulation on armature and fields.
5. Cartridge type bearing housings with large seals.
6. Grease overflow on commutator end bearing.
7. Pressure-relief system of lubricating bearings.
8. Exceptional commutating ability and brush life — motors designed for frequently repeated torque peaks of 500 per cent of rated torque.
9. Heavy cast radial brush holders with porcelain insulators.

Figure 6 is a cross-sectional view of a modern Type MDY table motor having these features.

The following design improvements have been made in Type MDY motors:

1. The cover design has been changed so that the cover clamps do not limit roll spacing. (See Figure 6.)
2. Designs have been made to permit roll spacings as low as 14.5 in. for motors rated 4-hp, 750-rpm.
3. Thyrite shunt field discharge resistors are now mounted in the bottom portion of the motors.
4. The bearing design has been changed from the original two ball bearing design involving one floating outer race to a commutator end ball and drive end roller bearing design. The races of both bearings are locked. Shaft expansion is taken in the roller bearing (see Figure 6).
5. The armature coil insulation of the early motors was asbestos on a copper conductor with a final taping of asbestos. An intermediate step in improvement involved the use of formex varnish and felted asbestos on the copper. In the present motor formex varnish and double glass yarn is used on the copper, with a final glass taping over the whole coil. (See Figure 7 for photograph showing armature and bearing cartridge construction.)
6. Shunt and commutating pole construction (shown in Figure 8) has been improved in two respects:
   a. The asbestos pad, formerly placed between the field coil and the frame is now wrapped into the coils.
   b. Coil terminals formerly of the set screw type are now of the flat type using special locking cup washer.
7. One or both commutating pole coils include a thermal device lashed to the coil. (See Figure 9.) One device trips at maximum safe temperature of the motor and, if the second is used, it trips at a lower warning temperature.
8. Shunt fields now suitable for 250-volt excitation power — original designs used 90-volt fields.
9. Speed regulation has been improved. Present speed regulation on a typical design is 2.7 per cent full load to no load and 5.4 per cent with 500 per cent load to no load.
10. Machined fits and pole bolt heads are now sealed

Figure 6 — Cross-section of type MDY, frame 441AA2 runout table roll motors.

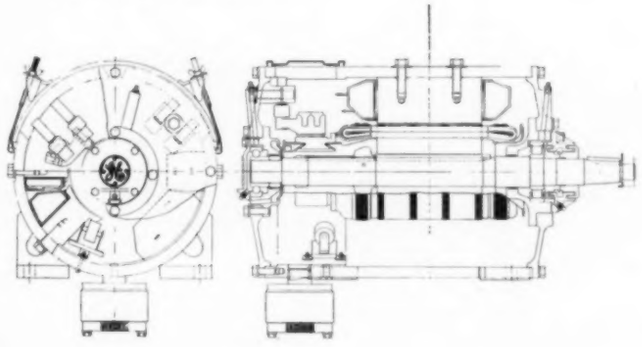


Figure 7 — Armature for type MDY motor shows bearing cartridge construction.

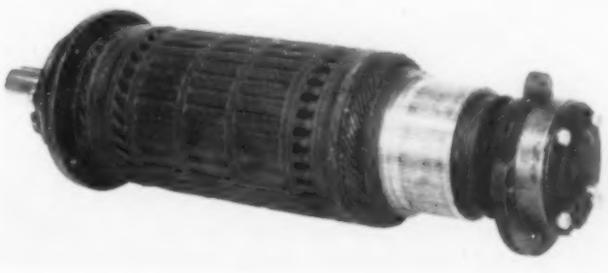


Figure 8 — Illustration shows shunt and commutating pole construction for MDY motor.

with an asphalt compound. Copper washers are used under the pole bolt heads.

11. Bearing seals on drive end have been improved by the addition of an outer labyrinth seal to prevent entrance of water into drive end bearing.

Several runout table installations have used motor lead couplers to simplify lead disconnection when removing a table roll assembly or a motor. Experience has shown that these couplers are not necessary because motors are seldom removed and are, in fact, objectionable because water gets into the couplers and causes corrosion and bad connections.

Brush life of Type MDY table motors has been exceptionally good. One mill has not changed a brush during its first three years of operation. Another mill reports an average brush life of about five years.

PROTECTIVE CONTROL PANELS FOR INDIVIDUAL TABLE ROLL MOTORS

An individual table roll motor can be overloaded for long periods of time, requiring thermal overload protection, under one or more of the following common conditions:

1. Bad roll or motor bearings.
2. Warped or damaged aprons rubbing on the rolls.
3. More than normal weight of strip on a roll when strip piles up on a table.

A roll motor can be stalled suddenly, requiring instantaneous overload protection, under one or more of the following common conditions:

1. Failure of roll or motor bearings.
2. Warped or damaged aprons locking the rolls.
3. Strip jammed between apron and roll.
4. Heavy magnet or slab held on table by crane or jammed across table.

A roll motor can also be subjected to other abnormal conditions, such as:

1. Short circuits in armature.
2. High inrush currents occurring when starting a dead motor across an energized bus.
3. Loss of field.

For safety reasons, disconnecting means must be provided for armature and field circuits and for any other circuits such as temperature devices that enter and leave the motor.

Individual table roll motor protective control panels, one for each motor, usually provide features of:

1. Instantaneous overload protection.
2. Thermal overload indication.
3. Loss of field protection and indication.
4. Complete electrical disconnection of motor leads.

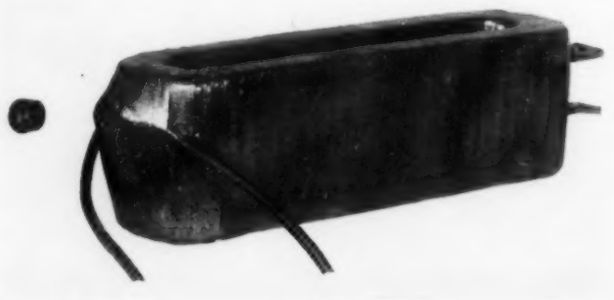
The circuits for one of the conventional types of protective controls is shown in Figure 10.

Experience with the protective control panels of this type has led some users to ask for the inclusion of additional features in a few instances, such as:

1. Thermal overload protection automatically removing power from the motor armature as well as thermal overload indication.
2. Remote reset together with thermal overload protection to eliminate the chore of walking to the protective panel and manually resetting the tripped device. Some conditions causing tripping of thermal overload protecting devices such as a cobble on the table are corrected in the course of normal operation and do not require walking to the motor to determine the cause of the overload.
3. A light on the top of a group cabinet saves time in locating motors in trouble.
4. A light giving warning of abnormal conditions, such as bad roll bearings or rubbing aprons.
5. Interlocking to prevent throwing a dead motor on a live table section bus.

A new individual and group roll motor protective control system has been designed that includes the above features. The elementary diagram for this system is shown in Figure 11. This control system is based on the use of one temperature detecting device mounted on each of the two commutating pole windings of a type MDY motor. One device is selected to trip at a maximum safe temperature of the motor armature of 115 C. The other device on the second commutating

Figure 9 — Type MDY motor commutating pole winding has thermal device wrapped in coil and a second device shown externally.



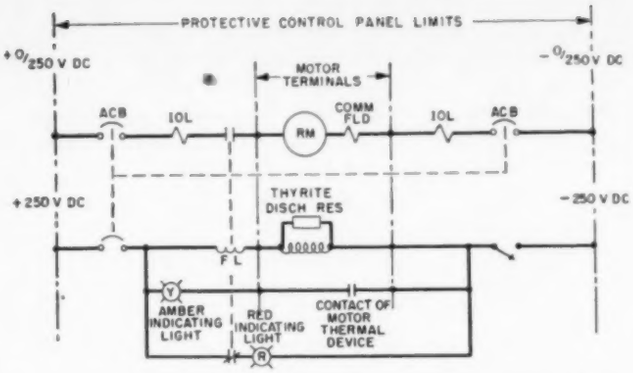


Figure 10 — Individual roll motor protective control has field loss protection and indication, instantaneous overload protection and thermal overload indication.

pole winding is set to trip at a lower temperature, such as 85 C, and is intended to warn against conditions that cause motor overheating.

A study of the elementary diagram of Figure 11 will show how the following protective and operating features are obtained:

1. Instantaneous overload and short circuit protection obtained by overload devices (IOL) built integrally with the air circuit breaker (ACB).
2. Thermal overload protection closely approximating motor heating using a thermal device (TT) mounted on one commutating pole winding of the motor which trips at a maximum safe motor temperature removing armature power from the roll motor.
3. Loss of field protection is provided by a contactor (FP) having a coil in series with the field and a contact in the coil circuit of the main armature contactor (M).
4. Complete electrical disconnection of all motor leads not at ground potential is provided by manual opening of the air circuit breaker (ACB) and the three-pole knife switch.
5. Remote reset after thermal overload tripping of all tripped motors in a table section by means of one pushbutton for each table section located in operator's pulpit.
6. A dead motor cannot be thrown on a live bus. Motor protective control cannot be reset before the section no voltage relay (VR) is de-energized.
7. Indication of the group that has motors in trouble is given by a large light mounted on the control cabinet for a group and a smaller light electrically in parallel mounted on the operator's pulpit.
8. Indication of motors in trouble in a given group is given by an indicating light on the door of each motor protective control panel enclosure.
9. The group lights and individual protection control panel lights go out when:
   a. Motor heating causes closing of warning thermal devices (TA).
   b. Motor heating causes opening of maximum safe motor temperature device (TT) and contactor (M).
   c. Instantaneous overload or short circuit causes tripping of air circuit breaker (ACB).
   d. Loss of field relay (FP) opens contactor (M).

The above are not the only features that can be included in a comprehensive roll motor protective control system. An instantaneous overload relay and another three-pole line switch can replace the air circuit breaker (ACB), providing automatic reset even on instantaneous overload tripping.

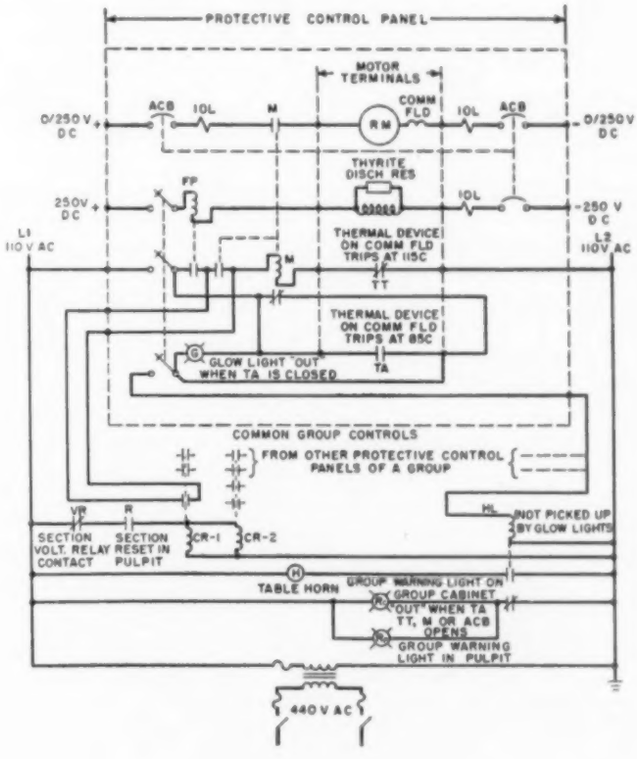
Figure 12 shows a conventional design of table motor protective control built in a modern compartment type enclosure. It should be noted that each motor protective control unit has mounted in the compartment door:

a. An indicating light to locate the motor in trouble.
b. An armature ammeter to show motor load torque.
c. A shunt field rheostat.

The ammeters of Figure 12 were included at the purchaser's request to indicate abnormal load torque conditions such as rubbing aprons or bad bearings. The trouble is that ammeters are of no use until someone reads them, and on a runout table there are too many ammeters too far apart for any reasonable number of men to check constantly. The proposed control system of Figure 11, by means of the thermal alarm device (TA) built into the motor, overcomes this objection and eliminates the need for ammeters. Experience has shown that the shunt field rheostats are not required and are therefore not included in the control system of Figure 11.

The modern practice of building protective controls is to group 10 or 12 controls in an enclosure such as shown in Figure 12. These enclosures are located against the building wall on the same side of the tables as the motors — namely, the side opposite the operating side. Because all of the devices in the enclosures of the

Figure 11 — Individual motor protective control with field loss contactors, and one air circuit breaker including instantaneous overload relay provides thermal overload protection, thermal alarm and table group reset from pulpit.



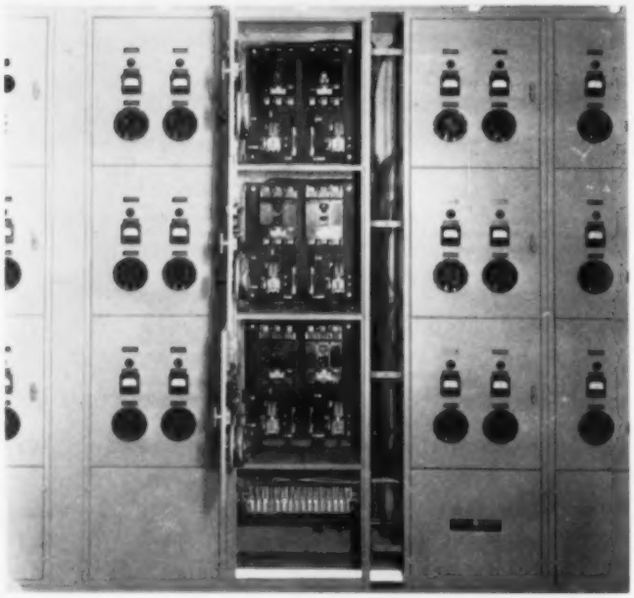


Figure 12 — Individual roll motor protective control is front connected in modern compartment type enclosure for locating against the wall.

modern equipments are front-connected, the controls take up little space and do not usually project beyond the building columns.

Some of the original installations included protective controls for two motors mounted under the motors along the table. This practice was soon abandoned because strip and other objects hung from cranes damaged the control cases. It is now almost universal practice to locate controls as far from the table and crane sweep as possible.

ROTATING REGULATOR TYPE IMPROVED GENERATOR CONTROL

The original generator field control equipments employed timed generator field contactors for control of accelerating and decelerating rates. In a paper entitled "Improved Control for Runout Tables" by B. Starie, printed in the 1944 Proceedings AISE, p 411, the then new rotating regulator type of generator field control was described. Since then, some further improvements have been made in these control circuits.

The features of the modern rotating regulator type generator field control system, the circuits for which are shown in Figure 13, are:

1. Current limit control of acceleration and deceleration of a table section providing maximum possible rates of acceleration and deceleration for the maximum allowable current peak on the generator.
2. Voltage regulation during running, either against a manually preset standard or a speed indicating pilot generator, providing automatic speed synchronization with the mill for each table section.
3. Minimum table speed provided when operating synchronized with the mill, below which the table will not decelerate, even though the mill should stop, to allow runout of strip left on the table without switching to manual operation.
4. Reference for current limit circuit is now an isolated circuit supplied from rectified 110-volt, a-c power and an insulating transformer eliminating troubles from grounds in the general excitation system.
5. Stabilization is accomplished through capacitor coupling rather than transformer coupling, providing more flexible means for obtaining stabilization.

Rotating regulator control components have been combined into a panel mounted package (box) with hinged door. See Figure 14. This has made possible the reduction in width of a section generator panel to 30 in. or even less.

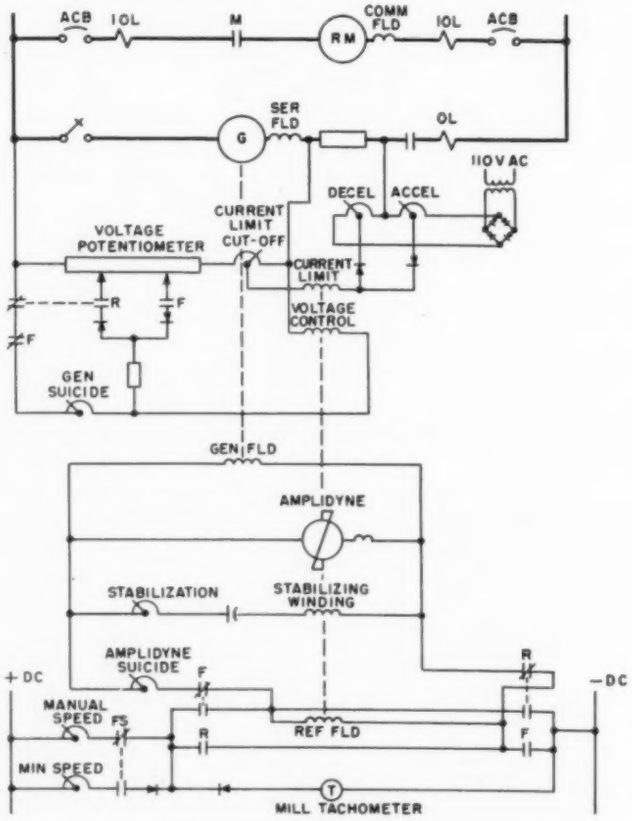
TRENDS IN COILER DESIGN AND COILER DRIVES

An examination of Table I discloses that wide hot strip mills which use d-c runout table drives employ mainly two general types of coilers: the surface driven expanding type and the center driven mandrel type. This paper will, therefore, be concerned only with these two types of coilers.

There has been a marked trend since 1945 toward the use of the center driven mandrel type coiler because:

1. It is not as limited in the amount of power that can be exerted on the strip as is the surface driven expanding type which has only a very limited space for coiler roll motors. See Figures 15 and 16.
2. The greater power available for strip tension

Figure 13 — Elementary diagram of a modern rotating regulator type control equipment for a runout table section generator.



results in coils with smooth ends. This greatly reduces damaged strip edges when the coils are up-ended on the coil conveyor, reducing edge cracks when cold rolling.

3. Cobbles and coiler trouble are reduced. The coiler roll motors of the surface driven expanding type are frequently overloaded, with resultant tripping of line contactors and loss of power during the coiling operation.
4. The coiler rolls of the surface driven expanding type have not enough traction surface on the strip for proper coiling of large slabs in narrow widths.
5. Surface scratching of the strip is greatly reduced — an important factor when coiling stainless steels.
6. The mandrel motor is not subjected to bad water conditions and is more conveniently located, facilitating maintenance. Coiler roll motors of a surface driven expanding coiler are constantly sprayed with water. See Figure 16.

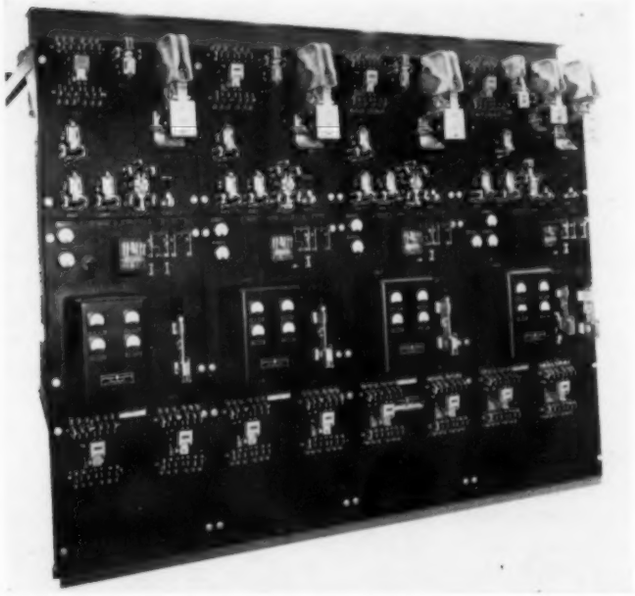


Figure 14 — Control panel for 4-table section generators shows modern panel mounting of rotating regulator circuit packaged controls.

The trend toward the center driven mandrel type coiler is further accented by the fact that one mill (Item 18, Table I) has actually replaced surface driven expanding coilers with center driven mandrel type coilers. Another mill (Item 28, Table I) has replaced a-c surface driven expanding coilers with a modern design of d-c surface driven expanding coilers to which mandrel motors can be added in the future, permitting dual operation. Figure 17 shows the bridge from which the runout table was suspended to keep the mill in operation during the construction work for the addition of the two new coilers.

Several of the center driven mandrel type coilers of Table I have the same number and size of coiler roll motors as used on surface driven expanding coilers, thus permitting "dual" operation. When the coiler rolls and mandrel are operated simultaneously, some additional strip tension is developed by the coiler rolls. Another function of the coiler rolls is to obtain an "ironing" action contributing to the tightness of the coil and holding it tight after the end of the strip leaves the pinch rolls. Sometimes coilers are operated by retracting the coiler rolls so that they do not ride on the strip after threading the mandrel, and coiling is done simply by the mandrel, except that the coiler rolls are contracted on the coil as its end leaves the pinch rolls. In other cases, the mandrel is retractable and coiling can be done using the surface driven expanding principle only.

Figure 15 — Hot strip downcoiler, surface driven expanding type, shows limited space available for coiler roll motors.

Most coilers of either type tend to be down-coilers. Of fourteen coilers arranged for center driven mandrel operation or dual operation, ten have been down-coilers and four have been up-coilers. The choice of an up-coiler against a down-coiler seems to depend mainly on mill design, space available for the coil conveying system, and ease in applying necessary quantities of water to the strip surface.

In discussing developments of motors and controls for surface driven expanding and center driven mandrel type coilers, the dual type will not be specifically discussed since the developments made in electric equipment for each type apply to the dual type.

DEVELOPMENTS IN MOTORS AND CONTROL FOR SURFACE DRIVEN EXPANDING TYPE COILERS

The modern type MDY, d-c coiler roll motor (see cross-sectional view of Figure 18) has the same basic features as those of the first motors built in 1937. These are:

1. Mill type construction — totally-enclosed, non-ventilated.
2. One-piece cast steel frame sealed for water tightness, with recessed pole bolts and lifting eyes.
3. Large commutator end handhole covers, gasketed and quickly removable.
4. Class B insulation on armature and fields.
5. Cartridge type bearing housing on commutator end with large seals on both ends.
6. Grease drainage chamber between two shaft seals on drive end to prevent grease from the coiler roll gear case from finding its way to the drive end motor bearing.
7. Pressure relief system of grease lubricating bearings.

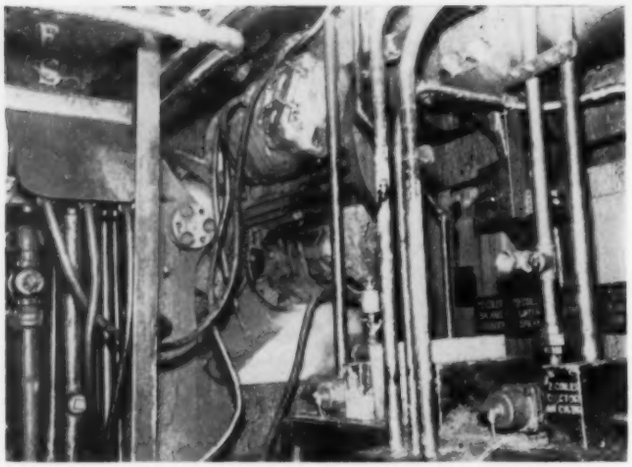


Figure 16 — Surface driven expanding downcoiler shows coiler roll motors in the position for receiving strip. Note space restrictions and dripping water.

8. Exceptional commutating ability and brush life—motors designed for frequently repeated torque peaks of 500 per cent of rated torque.
9. Heavy cast radial brush holders with porcelain insulation.
10. Drain holes.
11. Extended flexible leads with couplers.

The following design improvements have been made in Type MDY motors since the first motors were built and are included in the modern motor:

1. Increased torque and horsepower for a given space can be obtained, if required, by using glass and silicone insulation for 100 C, 8-hour temperature rise over a 40 deg ambient.
2. Spherical seat roller bearings are now used on the drive end rather than straight roller bearings for increased radial loading and to permit slight shaft deflection.
3. Armature coil and pole construction has undergone the same improvements as previously described for the Type MDY runout table motors.
4. Thermal devices are now lashed to the commutating pole windings as described for Type MDY table motors.
5. Drain plugs at both ends at various points have been added. Those drain plugs at the bottom of the motor depending on motor mounting position are removed and drain holes left open.
6. Shafts are made of alloy steel in some ratings with more liberal shaft fillets.

Some trouble has been experienced from shaft breakage. This has been traced to the shifting of motors due to inadequacy of the mounting register surface which was greatly reduced to allow for the motor bearing housing bolts and obstructions in the coiler housing (see Figure 19). New designs have increased register bearing surface.

For the coiler roll motors, complete line panels providing the same features as the protective panels for table motors are included in the line-up with the generator control panels. The motor couplers at the coiler provide the disconnection feature. Thermal devices lashed to the commutating pole windings are strongly recommended for coiler motors. Couplers must now provide additional contacts for the leads of the thermal devices.

Coiler generator controls include the same features as table generator controls. Speed synchronization either with the last mill stand or the table section ahead of the coilers can be provided. For mills in which the strip is in the coiler and the mill during most of the coiling

Figure 17 — Construction work is in progress for two new coilers which replace two existing coilers. Mill is kept in operation by suspending runout table from bridge.

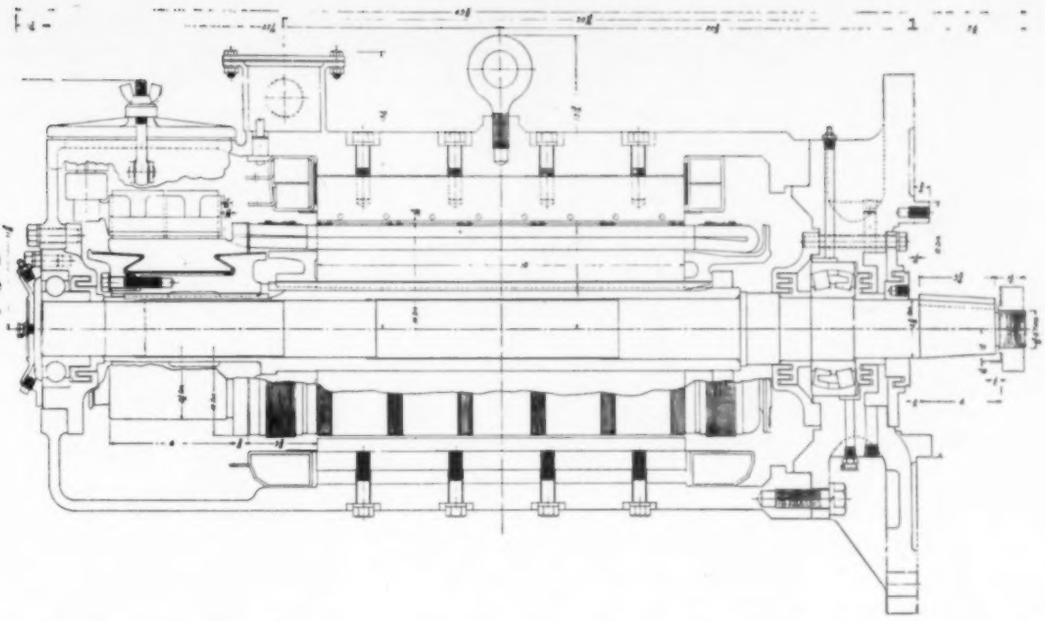


Figure 18 — Cross-section of type MDY, frame 442BY, coiler roll motor.

time, synchronization with the mill is indicated rather than with the table.

Figure 20 is a recording chart of amperes to the armature of one coiler roll motor of a 76-in. surface driven expanding down-coiler supplied with power from a rotating regulator-controlled generator. The five roll motors are each rated Type MDY, 15-hp, 975-rpm, 250-v, 49.0-amp full load current. An examination of the chart shows that when coiling comparatively thin and narrow strip, 0.074 in. × 32⅛ in., at 1275 fpm loads are as follows:

1. Starting current peak = 106 amp = 217 per cent.
2. Starting and stopping time = 6 sec.
3. Stopping current peak = 130 amp = 265 per cent.
4. Load current when coiling with strip in mill = 66 amp = 135 per cent.
5. Load current after strip has left mill = 48 amp = 98 per cent.
6. Approximately one-third of motor torque is used to produce tension when strip is in mill and coiler.

The horsepower rating of a roll motor of a surface driven expanding coiler is usually the maximum that can be obtained in the space available at the required speed, and its decelerating time with full coil is thus determined. This will be one rating for a 75 C rise, Class B insulated motor and approximately 25 per cent higher for a 100 C rise, glass and silicone insulated motor. Experience with similar coilers largely dictates the choice.

Coiler generators should be selected like table generators, assuming the coiler motors develop 350 per cent average torque during acceleration and deceleration. The fact that a coiler generator also may supply some of the table roll motors of the table from the coilers to the piler may result in a coiler generator of larger capacity than required just for the coiler.

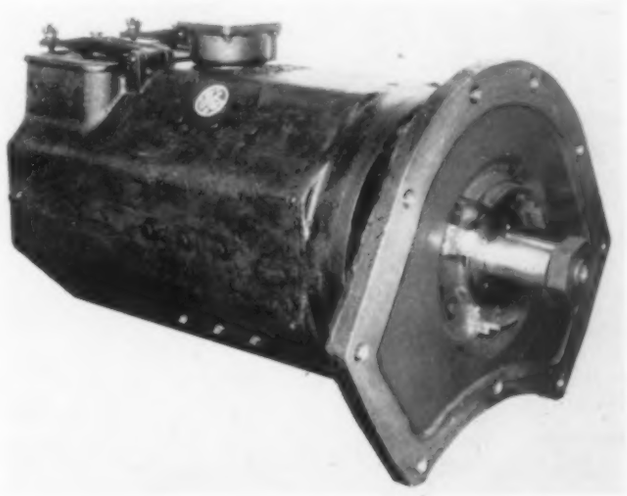
Maximum coiler roll speeds at *no load* should be approximately 20 per cent higher than maximum mill speed. First of all, the coiler should run at least as fast as the table, which usually runs 10 per cent faster than the mill. Secondly, because load balancing resistors are usually used in the individual roll motor armatures, some extra allowance must be made for the drop in speed when coiling due to these resistors.

DEVELOPMENTS IN MOTORS AND CONTROL FOR CENTER DRIVEN MANDREL TYPE COILERS

A. *Mandrel Motors*

The coiling cycle of a center driven mandrel type coiler involves threading and winding the strip on a mandrel. Mandrels are smooth collapsible reels with axis horizontal. Before the strip can be wound on the mandrel, it must be turning with a surface speed higher than strip speed, say 5 or 10 per cent. This overspeed is commonly called lead speed. As the strip starts winding on the mandrel, being guided by wrapper or coiler rolls, it snubs the mandrel and its motor down to

Figure 19 — Type MDY motor for surface driven expanding downcoiler shows mounting flange and cut-outs in register surface.



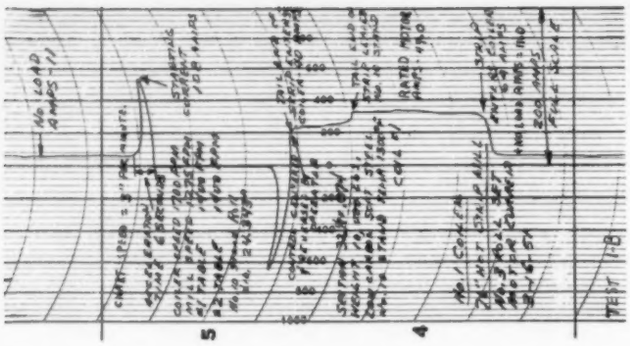


Figure 20 — Recording ammeter chart of armature current to a roll motor of a 75-in. surface driven expanding downcoiler supplied from rotating regulator controlled generator.

strip speed. The energy stored in the mandrel and its motor due to lead speed is dissipated as the strip slips on the mandrel. After a few wraps, the strip grips the mandrel. The mandrel exerts tension on the strip, pulling against the last mill stand, as long as the strip is in it, then later against the coiler pinch roll and the friction drag of the strip on the table, if any. As the coil is wound, the mandrel speed must be decreased for the increasing coil diameter and strip tension must be held constant. When the coil is completely wound, the wrapper rolls, mandrel and coil must be stopped quickly, the mandrel collapsed, and the coil pushed off. The mandrel and wrapper rolls must then be restarted as quickly as possible to be ready for the next slab.

D-c mandrel driving motors should have the following special characteristics to meet the requirements of the coiling cycle to best advantage:

1. Reasonably flat, slightly drooping speed regulation at weak field so that the overspeed with the coiler running light is not excessive.
2. Speed range by field control of approximately 2½ to 3 times base speed, for the usual amounts of build-up.
3. Low inertia, so that the stored energy due to lead speed is kept to the minimum. Sometimes strip grips the mandrel rather suddenly and the lower the stored energy the less is the resulting "jerk."
4. High accelerating and decelerating torque peak capacity, such as 300 per cent at base speed for high rates of acceleration and deceleration.
5. Robustness of mechanical and electrical design, such as built into mill type auxiliary motors.

A recent development involves the use of compensating pole face windings in Type MD motors rated MD-422X, 425 hp, 375/900-rpm, 230 volts, for driving mandrels of four new coilers. For smaller ratings not available with compensating pole face windings, ordinary shunt motors without stabilizing windings can be used. The resistance in series with the armature used to furnish a voltage proportional to current to the regulating system provides the necessary stabilizing effect.

The horsepower rating of mandrel motors should be determined in the same manner as for winding reel motors of cold strip mills. The empty mandrel and motor inertia limits the rate of acceleration. The torque required to accelerate from rest to lead speed in the desired time, plus a slight allowance for friction should equal that torque corresponding to 150 to 175 per cent of full load current (depending on rating) with the mandrel motor field weakened at lead speed value. This is the *average* accelerating torque.

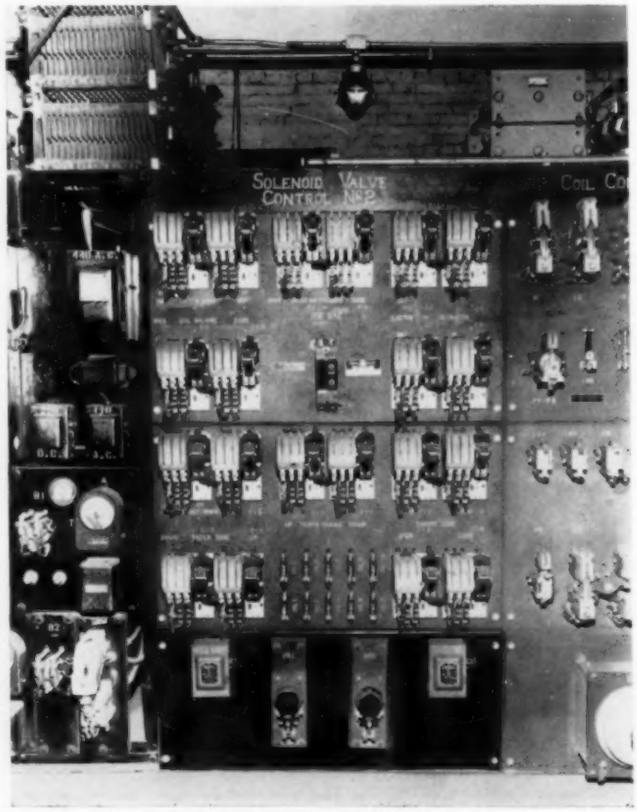
The ratio between the *average* accelerating torque determined as outlined above and the *maximum* torque during acceleration is somewhat lower than the 1.33 used previously for the acceleration of table motors with full field. This is because mandrel motors start with full field and the field is weakened during acceleration by the tension regulating system. It is, therefore, not correct to assume that only the torque at lead speed is acting throughout the entire accelerating period. It is suggested from experience that the current corresponding to the *average* accelerating torque at lead speed multiplied by only 1.25 represents the maximum current that the generator must deliver and this should equal the 300 per cent maximum momentary capacity of the generator.

To get some idea of the maximum strip tension to use in selecting mandrel motors, it can be stated that 350 hp for an 80-in. mill with a maximum mill speed of 2000 fpm has proven very satisfactory. This corresponds to 2.19 hp per inch of mill width per 1000 fpm of mill speed, or 72.3 lb tension per inch of mill width, and can be considered an upper limit figure.

B. *Wrapper Rolls*

Wrapper rolls of a coiler not arranged for dual operation serve the same purpose as a belt wrapper on a cold strip mill reel — namely, to guide the strip around the mandrel for the first few wraps. They are not intended

Figure 21 — Solenoid valve control panel for one surface driven expanding downcoiler provides thermal overload protection for valve solenoids.



to add tension to the strip as are the coiler rolls of surface driven expanding type coilers. The wrapper rolls are usually lifted off the strip after the mandrel is threaded, and lowered just before the strip end comes through the pinch rolls, but may be left riding on the strip throughout the coiling cycle.

Wrapper rolls are usually driven either singly or in pairs through gears. The motors are usually Type MDY flange-mounted and the shaft extensions carry the pinions. The motors have been rated from 3 to 7½ hp, depending on the speed rating with a short-time torque rating of from 1 to 1½ hp per hundred rpm of base speed rating. About 1½ to 1 speed range by field weakening has been provided and a tachometer generator has been coupled to and mounted on each wrapper roll motor. Many coilers have just two wrapper roll motors. Each motor operates with some permanent resistance in series with the armature.

Wrapper rolls have been driven both by Type MDY motors and special industrial type motors, but Type MDY motors should be used. The Type MDY motor has the special bearing design in the drive end with seals designed to keep the lubricant from the gear case out of the motor drive end bearing. Being a mill type motor, the Type MDY motor is mechanically more robust than the industrial type motor and, therefore, is better able to stand the severe conditions of coiler service.

SELECTION OF GENERATOR ARRANGEMENT FOR MANDREL, WRAPPER ROLLS AND DEFLECTOR PINCH ROLLS

A separate generator should be provided for each mandrel motor. The voltage of this generator is substantially constant during coil build-up but will vary in accordance with forcing needs during acceleration and deceleration.

Wrapper roll motors can always be supplied from the same generator that supplies the mandrel motor if it is permissible to weaken the fields to obtain an adjustment in the speed relationship between the mandrel and the wrapper rolls.

Coiler roll motors of coilers arranged for dual operation should be provided with means for adjusting the amount of roll overspeed with respect to mandrel surface speed. Field weakening control of the coiler roll motors can be used for this purpose. When the coiler roll motors are used alone without the mandrel, full field is necessary for maximum torque output, but then the speed of the coiler roll motors can be adjusted by adjusting the voltage of the coiler generator.

Most center driven mandrel type coilers have a pair of pinch rolls through which the strip passes at table level that are called "deflector pinch rolls." For a downcoiler, at least, there is one large diameter roll above the table pass line and another roll usually half the diameter of the top roll below the table pass line. Each roll is usually driven by a motor, the rolls operating as a pair of pinch rolls serving the purpose of:

1. Providing a resisting force for the mandrel to pull against, setting up tension in the strip.
2. Transporting strip to subsequent coilers.
3. Causing a downward bend in the head end of the strip, facilitating threading of the mandrel.
4. Folding the head end of thin strip that strikes the top deflector roll should it be bowed upward due to air resistance lifting it as it travels down the table.

Not all coilers have this arrangement of deflector pinch rolls but, since most of them do, this is the arrangement for which the following generator arrangements are recommended:

Case I — One Coiler — Supply deflector pinch roll from generator for table section ahead of coiler with necessary increase in table generator size for acceleration of deflector pinch roll inertia.

Case II — Two Coilers (No Provision for Third Coiler) — Supply deflector pinch rolls from two separate generators.

Case III — Two Coilers (With Provision for Third Coiler) — Supply deflector pinch rolls from one separate generator large enough for present and future deflector pinch roll motors with magnetic rheostatic reversing control for motors of each pair of deflector pinch rolls.

Case IV — Three Coilers — One separate generator large enough for three deflector pinch roll motors with magnetic rheostatic reversing control for motors of each pair of deflector pinch rolls.

NOTE: (Applying to Both Cases III and IV) — With three coilers, the longer accelerating and decelerating time resulting from the use of magnetic control and dynamic braking can be tolerated and some saving made over three separate generators with controls. However, with only two coilers, the use of magnetic control will be of some handicap in longer starting and stopping time.

SPEEDS AND SPEED SYNCHRONIZATION OF CENTER DRIVEN MANDREL TYPE COILER ELEMENTS

In the following discussion of coiler element maximum speeds, the maximum mill delivery speed and not the table speed is the reference or 100 per cent, although the maximum table speed must also be taken into account when the strip leaves the last mill stand.

The maximum no load speed of the deflector pinch rolls should certainly be equal to the maximum mill speed plus about 5 per cent to allow for speed regulation of the deflector pinch roll motors as they pull against the strip while it is still in the mill. It is not normally expected that the deflector pinch rolls slip on the metal. When the end of the strip leaves the last mill stand, the speed of the deflector pinch rolls will rise because the coiler mandrel now pulls mainly against the deflector pinch rolls and the deflector pinch roll motors must rise about 7 to 10 per cent above mill speed to regenerate power. There is practically no friction drag of the strip on the tables, since the tables are already running about 10 per cent above mill speed. Vernier adjustment of the deflector pinch roll generator (or motor fields if a separate generator is not used) is especially important to obtain this fine balance between motoring and generating action of the deflector pinch roll motors.

The no load speed of the mandrel should be approximately 5 to 10 per cent above mill speed for lead speed

action. After the end of the strip leaves the mill, the speed of the strip will rise perhaps as much as 10 per cent. The tension regulator for the mandrel motor which holds current by regulating generator voltage and adjusts the motor field for proper field strength in proportion to coil build-up will automatically adjust for this change in strip speed. Since the coil is partly built up on the mandrel, and the mandrel motor is running well below lead speed, this change in strip speed has no effect on calculations of the maximum mandrel lead speed.

The wrapper roll motors should be selected so that their no load speed is approximately 10 per cent higher than the maximum mandrel lead speed or 20 per cent above maximum mill speed. Because these motors operate with series armature resistance, they will develop approximately two-thirds full load torque when the strip hits the mandrel running at lead speed. As the mandrel and wrapper rolls slow down to strip speed, the torque output of the wrapper roll motors will build up to something slightly over rated torque.

Speed synchronization of the coiler elements, as well as manual speed adjustment, can be provided. The speed of the deflector pinch roll and lead speed of the mandrel and wrapper rolls should logically be referred to mill delivery speed, as indicated by a speed pilot on the last stand. This avoids a change in the table regulating system affecting the coiler system when coiler elements having separate generators are synchronized to table speeds. This statement is made on the basis that strip is in the mill and the coiler for at least half of the coiling time. If most of the coiling work is done with the strip out of the mill, such as on reversing mills, there is some reason for synchronizing the coiler elements with the table section preceding the coilers.

SOLENOID VALVE CONTROL FOR ALL TYPES OF COILERS

Coilers usually involve many solenoid operated valves for operating air cylinders, the failure of any of which shuts down the coiler. Frequently, when the pilot valves are not used, the valves stick and the high inrush current burns out the a-c solenoids.

The Inland Steel Co. has long advocated the use of thermal overload relays to protect solenoids from burnout and reduce the time required to re-establish coiler operation. (See control panel of Figure 21). This simple solution has proved so valuable that its universal use is recommended.

SUMMARY

A hot strip mill can produce as much as $20,000 of saleable strip in one hour. It is extremely important, therefore, that great attention be paid to the little things that improve runout table and coiler performance and reliability. This paper has summarized past experience and developments, each small in itself, but great in total result for improved performance and reliability. The paper has stressed careful selection of roll motors and liberal selection of generators. It has also presented the factors and lessons learned from experience that must be considered in obtaining desired table and coiler performance at least cost when building new mills, so that the lessons of past experience need not be re-learned for lack of knowledge thereof.

DISCUSSION

PRESENTED BY

W. R. HARRIS, Manager Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

R. A. GEUDER, Manager, Applied Engineering Department, Reliance Electric & Engineering Co., Cleveland, Ohio.

H. E. LARSON, Steel Mill Division, General Electric Co., Schenectady, N. Y.

W. R. Harris: I would, however, like to emphasize the remarks about selecting run-out table motors and generators on acceleration and deceleration torques rather than on free running loads. (Actually the most severe loading on the motors and generators occurs during acceleration and equipment selected on this basis will have more than adequate margin for running service.)

I would like to make another point on the elaborate protective controls for run-out table motors discussed in the latter part of the talk. Very few mills have utilized this control. With such control it is necessary to run several more leads to each motor and where several hundred motors are involved, the installation costs would be expensive. Such circuits have been available for a number of years and they have not found wider use for the above reasons.

R. A. Geuder: *Runout Table Drives* — In the manufacture of motors for runout table service, whether they be direct or alternating current, it is our thinking to include in them some experience gained from steel mills as well as other industries. As a matter of fact, we are using designs which are now quite popular on mining machinery, and where mill-type motors were not adequate.

Probably one of the greatest problems we have, outside of having plenty of overload capacity, is vibration and moisture, and how to protect against them. This without a doubt is the toughest hazard faced by a motor assigned to that job.

Mr. Larson made mention of several means by which motors might be connected to their rolls and I would like to suggest that it is a study of mechanics and electrics.

I reported some six years ago on the early installations of what was called "floating motors." I now have several details on this subject. There are installed and in successful operation, thirty-six hundred floating motors. A floating motor is a motor which requires no foot, and requires no coupling, but is supported directly on the roll-shaft.

Certainly, I do not want to leave the impression that a floating motor is the only way to drive a table roller, but if you will combine mechanics and electrics in your

design of the table, and take advantage of the simplicity of the floating drive, I think you will be amazed at what they will accomplish on a particular job.

Coiler Drives — On mandrel operation of hot strip coilers, it is true that we would suspect a wide strip should take more power during coiling than a normal coil. It has been my observation on those mandrel type coilers that the most practical arrangement, during the time that the strip is still in the mill, is to have the pinch roll carry zero current. Therefore on the mandrel, full current is going into tension. As soon as the strip leaves the mill, the pinch roll provides the restraining torque, and the mandrel under load continues as if nothing happened. The operators, however, have found it satisfactory to leave the mandrel current the same, regardless of strip width. There may be other opinions, but this has been my observation with the twelve or thirteen coilers with which I am familiar.

In this paper we have suggested that a-c runout table motors and a-c conveyor motors are a thing of the past, but I doubt if Mr. Larson means to leave that impression. I believe he was referring to high-speed runout tables, and when it is necessary to slow down in front of the coiler or to stop for plate operation, I am in agreement that d-c is indicated and preferable. On the other hand, for continuous running tables — some of which are being installed where speed changes are infrequent, there appears to be a considerable advantage in using a-c.

H. E. Larson: Mr. Harris rightfully calls attention to the increased complications of the improved table motor protective controls. These complications, necessary to obtain the features required by some steel mills, are not as great as might be assumed from a cursory glance of the elementary diagram.

Only one conduit is still required between a table roll motor and its protective device as with older types of protective controls. Formerly, the two armature and two field leads were carried in this conduit. Now four additional small wires for the two 110 volt, a-c thermal device circuits can be included in this single conduit. The additional four wires per motor and slightly larger conduit are an insignificant part of the cost of installation of a runout table.

The protective control equipment of Figure 10 involves three devices: one 2-pole air circuit breaker, one single pole field switch, and a field contactor, mounted on the panel and housed in an enclosure, plus two indicating lights mounted on the enclosure door. The improved controls of Figure 11 involve four panel-mounted devices: one 3-pole air circuit breaker, one armature contactor, one field contactor, and a 3-pole knife switch. The single glow lamp does not take up panel space as it is mounted on the door of the enclosure. The panel area required by the four devices of the new protective control is only about 25 per cent more than required by the three devices of the older control of Figure 10.

True, each group of from 12 to 20 motors for the new protective controls require three or four auxiliary relays, a control power transformer and two group indicating lights which were not used before. The cost of both this additional group equipment and its installation is relatively small on a per motor basis, and in many cases well justifies the features it provides.

Mr. Geuder correctly assumed that I do not intend to suggest that a-c runout table motors and a-c conveyor motors are a thing of the past on all types of mills. In Table I of my paper, I have listed 46 relatively high speed wide hot strip mills on which d-c drives have been used for tables and coilers. The records show that on these types of mills, d-c drives have been used almost to the entire exclusion of a-c drives.

But it was not the purpose of my paper to present again the case for d-c drives on this type of mill as this had already been done. Rather, it is the purpose of my paper to describe the developments that have been made in the d-c drives for this type of mill and to present the factors that affect the application of d-c drives to tables and coilers.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

NON-FERROUS SCRAP IS NEEDED TOO!

VISCOSITY CONTROL OF FUEL FOR OPEN HEARTHS

By HARVEY KROUSE
Fischer & Porter Co.
Pittsburgh, Pa.

. . . . changes in viscosity have an adverse effect on combustion . . . . control of viscosity, therefore, should increase fuel efficiency . . . .

▲ OPEN hearth operators and engineers have recognized for many years the variations in viscosity of "Bunker C" fuel oils and the unfavorable effects of the viscosity variations on uniform firing and combustion control of their open hearth furnaces.

It is not the purpose to discuss here the requisites of proper burner setting and furnace control, but it is sufficient to mention what generally takes place when a significant viscosity change occurs in the fuel oil. With the rate of flow preset to the burners, a viscosity change conversely alters the flow rate due to the hydraulic resistance through the burner ports, valve, and piping. Such a viscosity change will also have an adverse effect on the atomization of the oil, and in turn, its optimum combustion.

Such an occurrence calls, of course, for an adjustment of the flow of fuel oil at the burners, however, the viscosity swing may be gradual and several hours of increasingly poor combustion may transpire before the condition is detected and adjustments made. It is, therefore, highly desirable to have a constant viscosity maintained.

If the consistency of the "Bunker C" fuel oils was constant, the problem of maintaining uniform viscosity at the burners could be readily handled with the conventional temperature control through heat exchangers at the individual furnaces, or in the recirculating oil circuit. Unfortunately strict processing specifications are not adhered to when the heavier grades of fuel oils are produced and as a result, the consistency, and in turn, the viscosity of these fuel oils vary widely from one supplier to another and from one shipment to another.

It can be seen from the curves of Figure 1, representing the viscosity-temperature relationship of oils deliv-

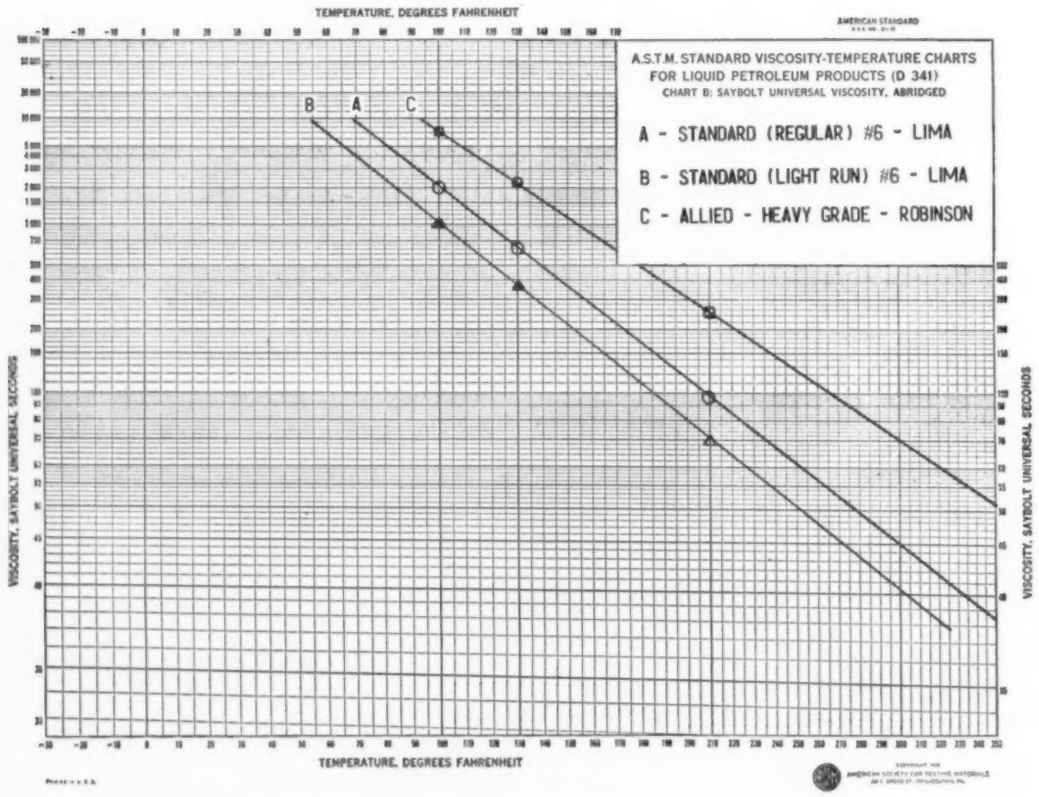

TEMPERATURE, DEGREES FAHRENHEIT
AMERICAN STANDARD
A.S.T.M. STANDARD VISCOSITY-TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341)
CHART B: SAYBOLT UNIVERSAL VISCOSITY, ABRIDGED
A - STANDARD (REGULAR) #6 - LIMA
B - STANDARD (LIGHT RUN) #6 - LIMA
C - ALLIED - HEAVY GRADE - ROBINSON
B
A
C
VISCOSITY, SAYBOLT UNIVERSAL SECONDS
VISCOSITY, SAYBOLT UNIVERSAL SECONDS
TEMPERATURE, DEGREES FAHRENHEIT

Figure 1 — Chart shows viscosity-temperature curves of No. 5 and No. 6 fuel oils from three different suppliers.

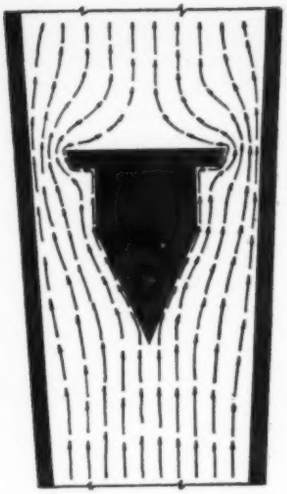
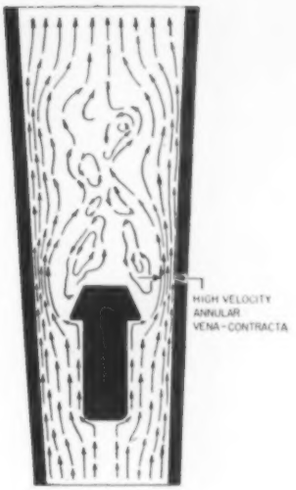


Figure 2 — Laminar flow pattern created by "plumb-bob" float.

Figure 4 — Sketch shows turbulent flow pattern created by float.



ered to one steel company by three suppliers, what has to be contended with. It is generally recognized that 150 S.S.U. is an optimum viscosity figure for burning fuel oil in open hearths. Let us assume that the "lightest" grade oil was in storage and burner adjustments were made in agreement with the oil temperature controlled at about 180 F. That would mean that the oil would be flowing to the burners at approximately 110 S.S.U.

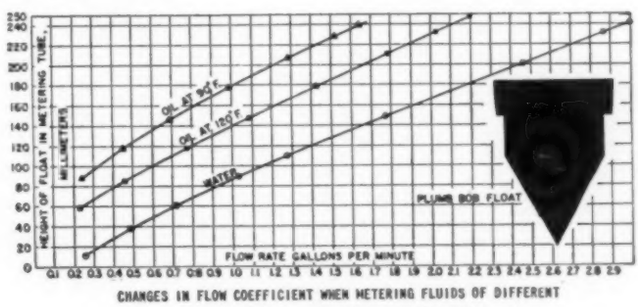
Now suppose successive car shipments of oil were emptied into the storage tank from the supplier represented by the second curve. As this higher viscosity oil replaced the original, the viscosity of the oil at the furnace would then be 170 S.S.U. By the same token, if the oil from the third supplier was introduced into the system and no adjustment was made of the control point of the temperature instrument, the resultant viscosity would be 500 S.S.U., a condition that would be entirely intolerable for combustion control.

We can further see that a temperature swing from 180 to 240 F would be required to establish the oil viscosity at the desirable magnitude of 150 S.S.U.

In actual practice, these extremes rarely occur in the recirculated oil because of the usually large volume in the storage tank tending to moderate the effects of new supplies entering the storage. Nevertheless, the changes are decidedly sufficient over a period of eight to twelve hours to upset furnace combustion and create a need for a method to control the viscosity variable itself and maintain it at a desired magnitude.

A viscometer has been developed and applied to this control requirement that continuously senses, records, and controls the viscosity of process fluids.

Figure 3 — Curves show changes in flow coefficient when metering fluids of different viscosities with the "plumb-bob" float.



CHANGES IN FLOW COEFFICIENT WHEN METERING FLUIDS OF DIFFERENT VISCOSITIES WITH THE "PLUMB-BOB" FLOAT.

The function of the viscometer is based on the reciprocal of the principle of viscosity compensating floats in the area-type flow meter common referred to as the "rotameter." The following will consider briefly the effects of rotameter float shapes on fluid stream patterns and how such affords viscosity compensation in flow measurement.

The conventional "plumb-bob" float of the earlier rotameters moving in the tapered section of the metering tube presented the streamlined, or laminar, flow pattern shown in Figure 2. Under these conditions, if viscosity of the flowing fluid was of any significance, the float was raised vertically in the tube by viscous drag as well as velocity. Therefore, a change was experienced in the meter coefficient in any given rotameter with fluids of different viscosities as shown graphically by Figure 3.

By substituting a float having a sharp metering edge presented to the flowing stream, a decidedly different flow pattern results in which a high turbulence is created around and above the float head.

The design of float shape, shown in Figure 4, provides automatic compensation for viscosity variations due to the fact that the turbulence around the metering elements minimizes or eliminates the effects of viscous drag and permits the float to be responsive to the one variable only, namely: velocity.

This condition is illustrated in Figure 5 where essentially the same three fluid viscosity conditions are being metered through a rotameter equipped with a sharp-edged, or viscosity-compensating float. The result is a common coefficient.

It should be stated that viscosity immunity afforded by this type of flow meter is directly related to and limited by the magnitude of flow. In other words, there is a ceiling to which any given metering element will provide absolute viscosity compensation and this ceiling increases or decreases with the flow volume and the capacity of the meter.

Establishing a continuous measure of the magnitude of the viscosity of a fluid is in effect applying the reciprocal of this principle of viscosity compensation.

In practice, a rotameter is installed in a sampling line of the main stream in which a continuous and repre-

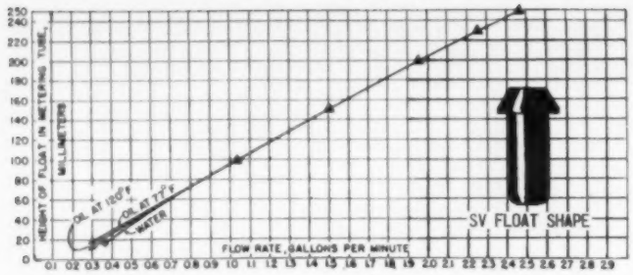


Figure 5 — Common coefficient when metering fluids of different viscosities with a sharp edged float.

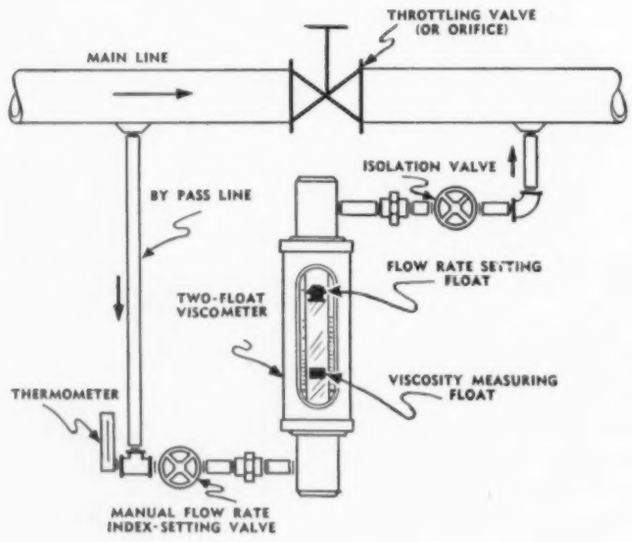
sentative flow is maintained. See Figure 6. The meter is equipped with two metering floats, one of which is the sharp-edged design and is immune to the viscosity variation. Its function is to indicate and provide a means of control of the flow rate through the by-pass circuit at some pre-determined flow index. A second float designed to be extremely sensitive to viscosity is installed in another section of the common metering tube. With the velocity thus controlled, any changes in position of the sensitive float will be a direct reflection of a change of the other variable, viscosity. A suitable scale in viscosity units is etched on the metering tube, which normally has a range of 10 — 1 following a logarithmic pattern.

Here we have the basic concept and functions of a metering device to continuously sense and indicate viscosity of a fluid expressed in kinematic units.

As applied to the measurement and control of the heavier black and opaque oils used in open hearth firing, it is obvious that additions to the basic metering element must be made. In the first place, a means must be employed to exhibit the float positions which otherwise are obscured due to the fluid opacity. Secondly, these float positions need be utilized for purposes of chart recording and automatic control of the flow rate of the sampling circuit and that of the viscosity of the fuel oil.

For most of the existing installations, an electrical transmission has been employed for this purpose and

Figure 6 — Sketch shows design of a 2-float viscometer.



reference to the cross-sectional drawing should be helpful in gaining a knowledge of its method of operation.

Essentially, the viscometer is extended top and bottom so that armatures embedded in the float rods moving in the fields of impedance coils set up a temporary unbalance of a modified inductance bridge circuit and in turn positions similar armatures in remote exhibiting instruments (Figure 7).

It should be noted that the fuel oil fills both of the extension wells and is isolated from the impedance coils by a stainless steel tube. By allowing the oil to fill the wells, no restrictive action is imposed on the action of the floats. As a consequence of this construction, the oil at the extremities of these extension wells would become cooler than in the flowing sections and during winter months could cool sufficiently to cause thickening and prohibit the free movement of the float. Viscometers for fuel oil use have been accordingly supplied with steam-jacketed float stops which impart sufficient heat to the extremities to keep the oil fluid, but not enough heat to affect the temperature of the flowing oil.

Before leaving the subject of transmission, it would be well to show the electrical diagram (Figure 8) of the modified inductance bridge employed, whereby the metering float positions are reproduced on the remote-recording chart when balance is established between the transmitting and receiving armatures.

By suitable linkage from the receiving balance arm to a conventional pneumatic controller installed in the recorder case, automatic regulation of the measured variable is attained. This paper will not encompass the functions of controller mechanisms other than to mention that a wide proportional band range and reset action are required, and in some instances, rate action or inverse derivative is desirable.

Represented in Figure 9 is a typical installation arrangement in an open hearth shop where the final heating of the oil takes place in the main recirculating line by means of a heat exchanger or a tank heater.

The flow is maintained at a set magnitude established by previous calibration by means of the controller and the throttling valve installed in the sampling line. A record of this flow is made for purposes of verification, but subsequent installations have proved that this record may be dispensed with. With the flow constant through the sampling circuit, the second exhibiting instrument records viscosity and provides the control impulse for this variable. The control impulse actuates the throttling valve in the steam line supplying the heat exchanger, or tank heater. Any change in viscosity of the oil downstream from the exchanger is immediately picked up by the viscometer and reflected in a proportionate adjustment of the steam valve and a return to the preset viscosity condition.

In Figure 10 are shown all but one of the components mentioned in the previous schematic diagram. Beginning at the left is first the viscosity recorder and controller, and next, the flow index recorder and controller. Then the viscometer with its two transmitting extensions, and finally the flow control valve. The steam regulating valve is not shown, nor is the temperature recording instrument measuring the temperature of the oil as it flows downstream from the tank heater. Attention should be called to the fact that the pyrex metering tube of this viscometer is enclosed in a metal body due

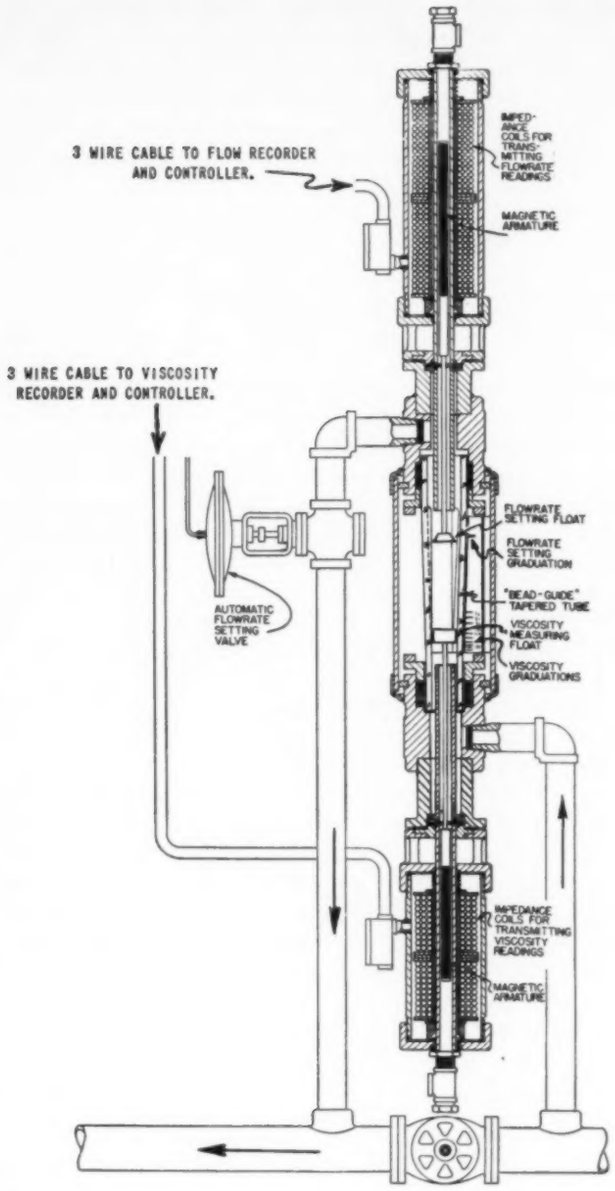

3 WIRE CABLE TO FLOW RECORDER AND CONTROLLER.
3 WIRE CABLE TO VISCOSITY RECORDER AND CONTROLLER.
IMPEDANCE COILS FOR TRANSMITTING FLOWRATE READINGS
MAGNETIC ARMATURE
FLOWRATE SETTING FLOAT
FLOWRATE SETTING GRADUATION
"BEAD-GUIDE" TAPERED TUBE
VISCOSITY MEASURING FLOAT
VISCOSITY GRADUATIONS
AUTOMATIC FLOWRATE SETTING VALVE
IMPEDANCE COILS FOR TRANSMITTING VISCOSITY READINGS
MAGNETIC ARMATURE

Figure 7 — This 2-float viscometer employs electrical transmission.

to the relatively high pressure at about 250 psig carried on the oil recirculating system. In this meter construction, the line pressure is balanced on either side of the glass tube insuring against rupture at this operating pressure.

One of the steam-jacketed float stops previously referred to is shown attached to the bottom extension with the supply and return steam lines.

So far, discussion has been chiefly confined to the principle involved in continuous viscometry and the mechanics required to apply these principles. It would be well now to relate the effects and results of such an installation and evaluate them in terms of better furnace combustion. At the same time, it would be well to point out the limitations and features that need improvement in such a control system.

For the purposes of these analyses, we will use as one example the installation where the photograph was

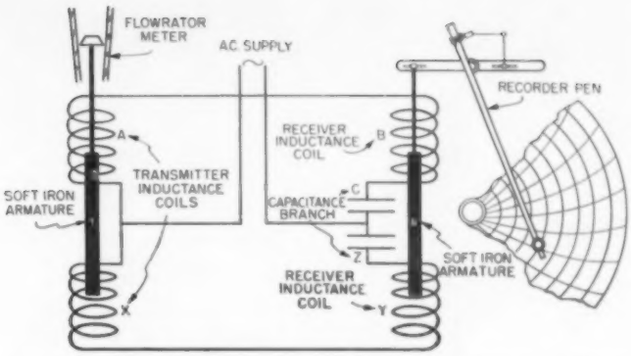


Figure 8 — Electrical diagram of the modified inductance bridge used.

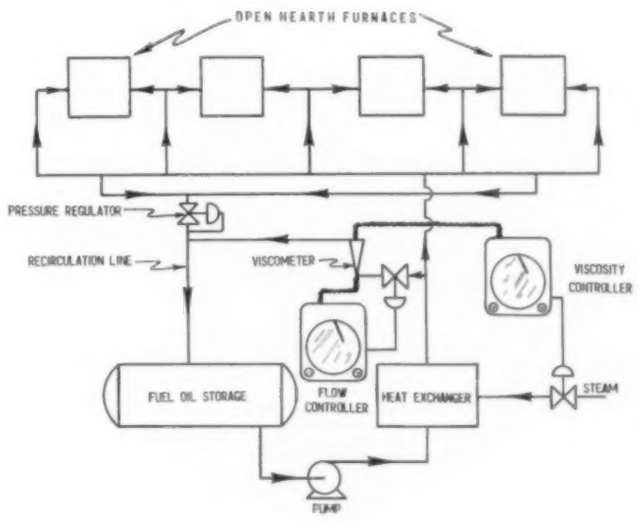
taken as shown by Figure 10. The recirculating oil system at this mill includes a large cylindrical tank installed horizontally as a heating device in which there is a series of 2-in. steam pipes. These coils are all on approximately the same plane near the bottom of the tank providing a single pass for the steam. The piping is also arranged in banks so that one or more bank can be isolated by manual valves thus providing more or less heat to the oil as demanded. The demand is occasioned by the temperature of the incoming oil and by the number of furnaces drawing fuel from this recirculating line.

Normally, however, the conditions are stable and there are infrequent occasions to change the number of pipe banks. The effects of such an unbalance will be shown on subsequent illustrations of charts taken from the recorder of the viscometer.

The condensate from each bank of heating coils is discharged through thermostatic traps replacing conventional tilt-type traps. The evidence of the control afforded by this installation is shown by the following set of charts (Figures 11-14) selected at random.

Figure 11 is a record of the controlled index flow rate. The chart is graduated in even spaces providing a 0-100 per cent reference scale. The index flow rate is maintained at 28 per cent, which represents approximately 2.5

Figure 9 — Schematic arrangement of fuel oil viscometer installation.



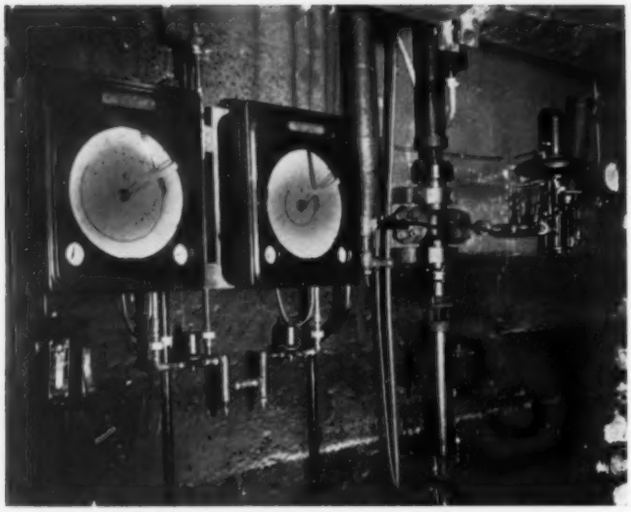


Figure 10 — Installation view of controlling viscometer.

gpm. It should be noted here the reason for the wide ink band produced by the pen. Actually, the band is painted by the pen as it swings over a span of about 4½ per cent of chart in response to the stroke of the steam reciprocating pump used to circulate the fuel oil. Since the strokes are of equal amplitude, this condition has only a momentary effect on control and equalizes perfectly.

Figure 12 is a simultaneous pen record of the controlled viscosity of the fuel oil for the same twenty-four hours. Following the line from the start, the control which was set at 70 per cent or 150 S.S.U. has been favorably maintained for the 24 hours with the exception of some minor upset occurring between 10:00-11:15 a.m.

Keeping in mind the consistently-maintained viscosity, let us examine the condition of the temperature of the oil over the same period. See Figure 13. The heavier inner line on the chart represents temperature of the return oil before entering the tank heater while the outer line shows the temperature of the oil after it leaves the heater and at approximately the location in the flow line where the viscometer sample was taken. The significance of this temperature record should be immediately apparent. At the start, the temperature was 216 F, and a gradual reduction took place until 24 hours later when the chart was removed, the temperature was 212 F. This gradual temperature change is the normal expectancy due to the large volume of oil in storage causing the effects of the variations in oil viscosity to be reflected over an extended period of time.

Consulting the temperature-viscosity slopes previously shown, it is found that an oil having a viscosity of 150 S.S.U. at 212 F will be 153 S.S.U. at 210 F. While the other extreme, at 216 F, will have a viscosity of 170 S.S.U. referred to 210 F as a standard. Related then to a common temperature, there is in this 24-hour period a swing in viscosity of the incoming oil to the system of 17 S.S.U. Examination of a series of consecutive temperature charts will show temperature differentials as wide as 20 F and an attendant viscosity swing of 55 to 60 S.S.U. It is readily recognized that a viscosity change of this magnitude would have decided effects on combustion control.

The set of charts just shown represents a normal operating condition but it would be well to analyze the chart Figure 14 which evidences a wide cycling condition for about 12 hours. Here is an instance where two furnaces were cut off from fuel oil firing resulting in a greater per cent of oil being returned to the heater. Obviously, there were too many banks of heating coils being used for the conditions and viscosity control got out of hand because of overheating when the steam-control valve was open — the valve being temporarily too large. As stated before, correction is made by manually cutting out one or more banks of heating coils until the normal load was re-established.

Control employing the tank heater as a heating element has been effective, entailing a minimum of in-

Figure 11 — Recording shows controlled index flow rate.

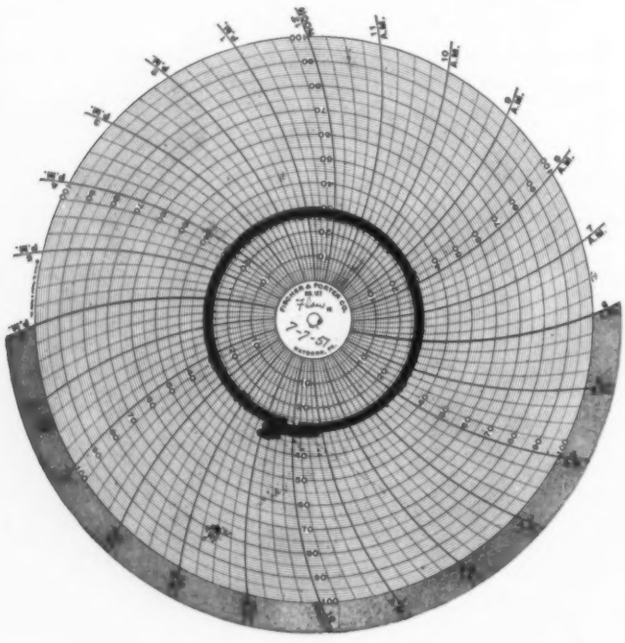
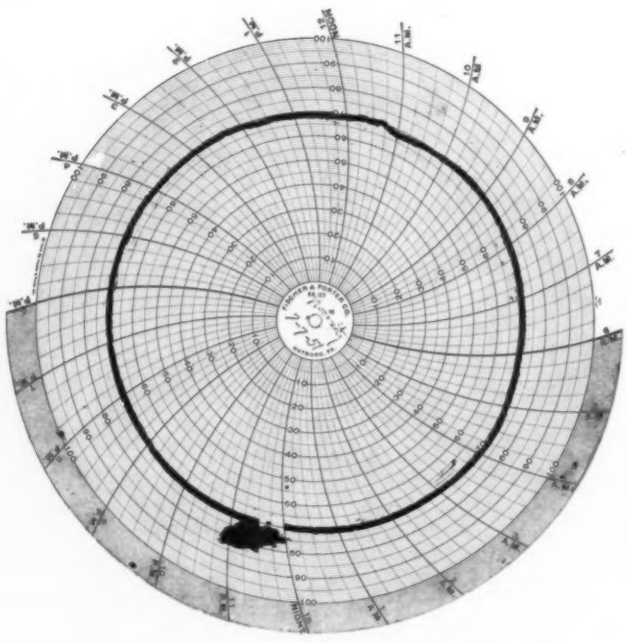


Figure 12 — Recording shows how viscosity was controlled.



stallation modifications or operational difficulties. It would appear at this time that this method of oil heating lends itself most satisfactorily to the viscosity control. However, most steel mills operate with a heat exchanger of a design which is most infamous from the standpoint of good control either through temperature or viscosity.

The original installations of continuous viscometers were made in conjunction with such heat exchangers and the history of much trial and error transpired before acceptable viscosity control resulted. It should be of interest to recount briefly some of the difficulties encountered and the corrective measures employed, or recommended.

Figure 9 shows a typical installation diagram. Examination of the flow circuit reveals that any pressure upset due to furnace reversals will be reflected anywhere within the pressured lines, including the sampling line of the viscometer.

Pressure upsets will occur sometimes as great as 20 psi causing a momentary change in flow rate through the viscometer circuit. The flow controller will attempt to correct for the change, but not having control of the main stream, the control efforts are abortive resulting in an irregular chart record but with the mean of the variations following the control point. Such flow upsets will also effect the viscosity-sensitive float and pen and be reflected in the viscosity control and record to a lesser degree. It is understandable that such a "bucking" control is undesirable.

Reduction of the effects of reversals has been considerably attained by the step reduction of the line pressure by regulators in the sampling line upstream from the viscometer, and also by placing the flow-control valve before the viscometer. Such modifications, of course, anticipate that little or no back pressure exists on the discharge line from the viscometer circuit.

Recognizing that flow control through the circuit established by a less sensitive device than a throttling type controller and valve would eliminate almost entirely the effects of main line pressure upsets, a single float viscometer with a differential pressure flow regulator has been developed.

In the cross-sectional diagram of Figure 15, it is observed that the sampled flow entering at the left is split two ways, part going around the valve head and a fixed quantity passing through the viscometer tube in which the viscosity float moves. A restrictive orifice is inserted in the outlet end of this branch. This type instrument employs a weighted float and a tapered tube orifice to maintain a constant differential pressure across the connections of the viscometer. This gives a constant flow sample regardless of line fluctuation.

A better conception of the construction of this design of viscometer is shown in Figure 16 incorporating an integral recorder and controller of the viscosity variable. For fuel oil service, the lower cylinder housing the valve weight is steam jacketed to prevent thickening of the oil.

It is obvious that this instrument, whether equipped with an integral exhibiting unit or transmission for remote functions, is not only hydraulically less involved, but physically simpler in construction and application.

Referring again to installations made in conjunction with heat exchangers, upsets in viscosity control are experienced because of the action of the condensate traps and because heat exchangers are used that usually have too much radiating surfaces. With tilt traps just having opened and the condensate purged from the heater, there will be an overheating of the counter-flowing oil. The controller actuating the incoming steam has no control over this upset. All it can do is to close the valve too late when the harm is already done. With the steam valve throttled near its closed position, condensate again building up, cooling occurs at an increasingly rapid rate, and the measured medium calls for more heat through the controller causing the valve to open wider than needed. Again the traps dump the condensate and the cycle repeats.

The proper answer to this adverse condition is the

Figure 13 — Recording shows variation in fuel oil temperature.

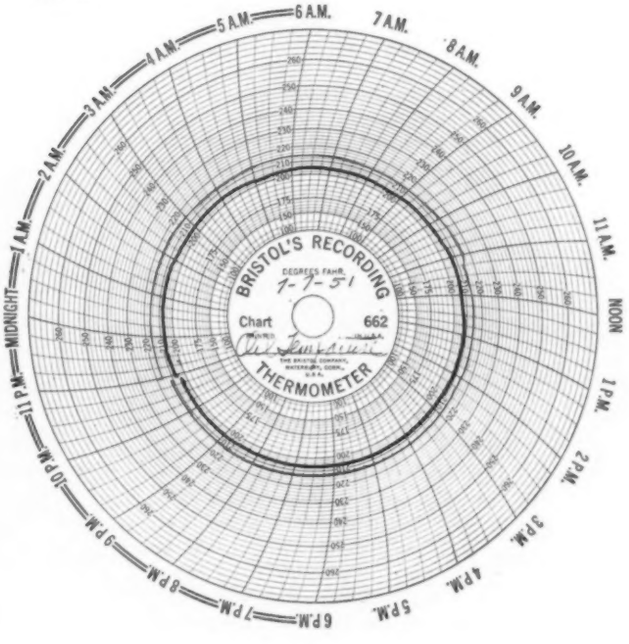
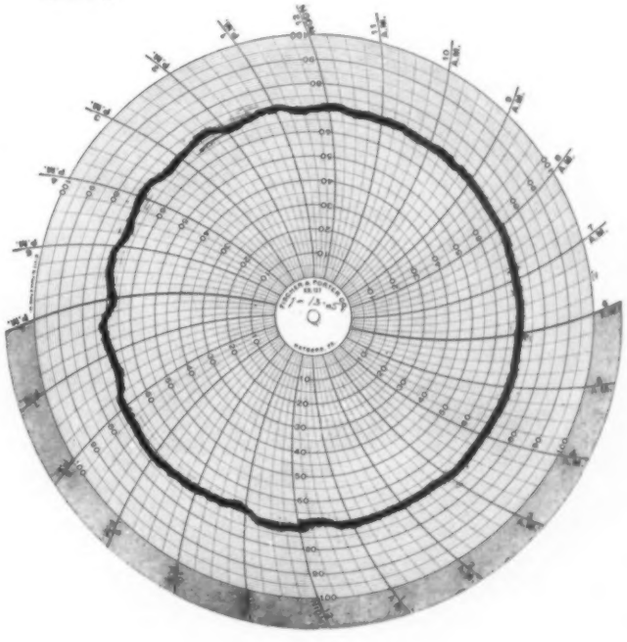


Figure 14 — Recording of controlled viscosity shows cycling.



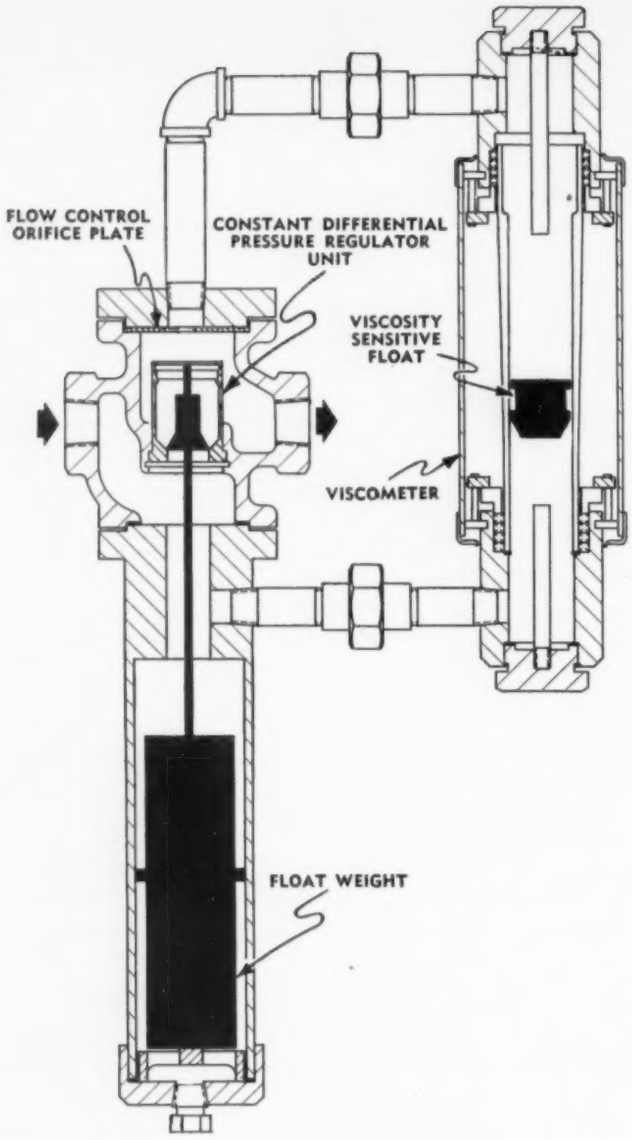


Figure 15 — This viscometer has a differential flow regulator.

selection of a heat exchanger adequately designed for the application with automatic control in mind.

With existing heat exchangers, control has been greatly improved and made acceptable with the substitution of thermostatic traps which maintain a steadier discharge of condensate and permit the steam valve to dominate the control picture.

There is always the most important consideration regarding the extent of maintenance required for any control equipment. Unfortunately a general and clear cut answer cannot be given to such a question regarding any instrument, regardless of its simplicity of construction or application, since the policy toward and the mechanics of instrument maintenance varies so decidedly from place to place. One user may have an efficiently organized instrument service group doing preventive maintenance, while another may be limited to emergency maintenance performed by personnel attached to a master mechanic's or pipe fitter's department. Naturally there results a vast difference in the performance and dependability of control equipment.

Generally speaking, the fuel oil viscometer as presently designed and properly installed requires the customary routine maintenance of control instruments. Such service entails the inspection of the recorder cases for tightness to prevent infiltration of fly ash, noting the freedom of linkages, and replacement of air filters. Naturally vigilance should be exercised with respect to the cleanliness and dryness of the air supply.

Specifically, the metering element of the viscometer should be inspected and cleaned at least every three months, mainly to remove accumulation of oil sludge either from the bottom extension of the two-float type, or from the weight chamber of the differential pressure type. It is good practice at the same time to clean the entire metering float and the inside surface of the metering tube with a suitable solvent. Where control valves and pressure regulators are employed in the sampling circuit, they should be thoroughly cleaned and inspected for possible wear.

Again it should be emphasized that preventive care reflects uninterrupted service and the attainment of the highest degree of performance satisfaction from instrumentation.

It is hoped that those concerned with the viscosity problem related to open hearth combustion may be guided to a means of regulation through this discussion.

Figure 16 — Viscometer has an integral viscosity recorder and controller.

DISCUSSION

PRESENTED BY

A. J. FISHER, General Manager, Bethlehem Steel Co., Johnstown, Pa.

HARVEY KROUSE, Fischer & Porter Co., Pittsburgh, Pa.

G. J. GOCKSTETTER, Chief Combustion Engineer, Republic Steel Corp., Chicago, Ill.

E. A. HAWK, Fuel Engineer, Tennessee Coal, Iron & Railroad Co., Ensley, Ala.

R. A. LAMBERT, Superintendent Steam & Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

G. H. KRAPF, Power and Fuel Engineer, United States Steel Co., Munhall, Pa.

JOHN R. GREEN, Manager Steel Div., Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

A. J. Fisher: During the war we had quite an experience with viscosity control and API gravity control which summed up is viscosity plus carbon-hydrogen ratio. We did not know too much about the control of these items at that time, but we did find out some ways and means of partially controlling them.

First, this experience was at Sparrows Point where we received large volumes of oil at one time. The oil came in by tanker lots, a hundred thousand barrels or more, and it varied from very heavy grades of oil to almost colored kerosene.

We found quite a bit of variation in these oils in respect to flame radiation. We changed the viscosity of the oil by temperature, the steam temperature, and the ratio of steam to oil — we used more steam and high temperature of steam and oil for heavy oils and less steam and low temperature of steam and oil for light oils. The effects that we obtained were still not entirely corrective but they helped materially. In other words, over a very large range of oil, viscosity corrections alone will not give you constant flame radiation effects. You must take means of controlling the flow of steam, the temperature of the steam and perhaps the design of the oil burner itself.

Harvey Krouse: I am purely reporting what the superintendent of the open hearth where these charts were taken told me. He said that he definitely had the control they wanted with respect to the viscosity, but still it did not answer all the problems of getting the number of Btu into the furnace. I thought I would just agree with what you said about it.

G. J. Gockstetter: When the viscosity of the fuel oil is controlled at one central point, it is conceivable that there would be wide variations at the burners. This could be caused by improperly lagged lines and loss in oil temperature, raising the temperature through steam traced supply lines and by the variation in flow through the supply lines. Have there been any tests made to show the amount of variation in viscosity at the heel of the burner with a centralized system?

Harvey Krouse: Yes, I would say that that had been checked and naturally there is a drop in temperature between the point of final heating and the various furnaces. That is very true, but it is usually a consistent temperature drop. Suppose the re-circulating system is such that it comes in at No. 1 and ends up at No. 9. It is understood that the temperature will be lower and, therefore, the viscosity higher at No. 9 than it will be at No. 1. However, a maintained constant viscosity at the initial point will be reflected through the system. It may not be the desired 150 S.S.U., but, at least, it will remain constant all along the line and adjustments can be made accordingly.

Regarding steam tracing, that is very important. It should not be over done so that the temperature will be increased in the remainder of the circulating system.

E. A. Hawk: If you had a ten-furnace shop, would you recommend two controls for that shop or one control? Would you get closer control if you had two, or if you had, say, one control for five furnaces?

Harvey Krouse: If your re-circulation rate is high, no, one is enough.

R. A. Lambert: The only comment I have is regarding Mr. Gockstetter's question and Mr. Krouse's comments relative to temperature drop from main line reheater to the burner. At our new open hearth shop in Pittsburgh, to attempt correction of what he mentions, we plan to install individual furnace liquid fuel reheaters and temperature controls for each reheater by the conventional method. Then we contemplate installing, on the main line, a pilot viscosity control unit which will give us the temperature of the liquid fuel at the controlled viscosity which we require for atomization. Then it is intended that every "turn" the combustion engineer will observe the temperature at the controlled viscosity and set the temperature controls at the individual temperature reheaters for each furnace.

G. H. Krapf: At the Homestead works of US Steel Co. we had the experience of operating one of the early viscosity controls. The shop is an eleven-furnace shop with line heaters in the circulating loop, with the line heaters after the discharge of the pumps and the return loop discharging it to the intake of the pumps. That installation had its trials and tribulations. I was wondering if Mr. Krouse would not like to review some of them that might be of interest and how they were corrected.

Harvey Krouse: I mentioned briefly that some of the earlier installations required a lot of trial and error to get them to operate. The one that Mr. Krapf referred to has never been a shining example of a control that I would like to see. I think we can explain part of the trouble, because of the fact that we have this reversal condition, whereby the pressure upsets are quite significant. We applied a pressure gage close to our point of operation and watched it during our experimental times and found that we had a swing of 30 psi during a reversal cycle. I do not know whether it was the effect of one or two reversals, but, at least, it was reflected on the pressure gage. We saw immediately that our controller on the flow control system attempted to control, but by the time it did, maybe the pressure was normal again. Then we would have another adjustment of flow control which, in turn, would reflect on the viscosity-

sensitive control, and naturally with the leaving of the control point, it would throw the viscosity control off. So, that is what I meant before by bucking controls, where you have that condition of trying to maintain flow control through a circuit that is not entirely controllable.

Now, with this new differential pressure type where we do not have that matter of two pneumatic control systems bucking one another in an upset pressure condition, I do not feel that you would have the same erratic-looking charts that were produced at Homestead. I want to say this in fairness to our efforts, the charts looked bad, but the control was not bad. Let me put it this way, our charts were painted; they were irregular; but over a twenty-four hour period they did show a mean of the control condition, and the mean did represent the index setting points of the controllers. This is proved by the fact that we had Homestead's previous temperature controller converted to a temperature recording and had recordings of the temperature over that period which were less looped than they were when the system was on temperature control. Now, I feel that control was established in a rough way. The charts reflected poor results and passed on to the top office, it looked bad, but from a control standpoint, I do think it was doing a fair job. However, there are three conditions that are undesirable. They are the overheating due to that heat exchanger, the pressure upsets, and the fact that the tilt-tip traps took away control from the steam valve in many instances. That is my analysis of that problem.

John R. Green: I would like to ask whether they have made installations, with any degree of success, employing a positive displacement pump as a means of securing a constant flow. I would like to ask also, whether the control principle of having the temperature control of the oil heater automatically reset from viscosity measurements has been used. There have been some adverse conditions in the design of oil heaters, but an automatic establishment of the desired temperature point from viscosity measurements is a successful means of overcoming these characteristics. As far as the individual measurement at the furnace is concerned, such a unit temperature control system at each furnace, all being reset from a master viscosity measurement would appear to be a more satisfactory and stable method of control.

Harvey Krouse: One question was about the pump maintaining the flow through the circuit, was it not? We would like to stay away from that on Bunker "C" oil simply because of the erosive effect that may occur in the impellers of the pump. Let us say it is properly calibrated to begin with, but you have no instrument to tell you what the fuel rate is if the pump wears. So that means the calibration of the viscosity-sensitive function is off. I would say that that would be the objection. However, on fluids that can be handled without any expected changes in the mechanical parts of the pump, viscosity measurement can be readily handled that way.

Returning to your second question, I think you have a good idea. I feel as though cascading of the two instruments might be a means of overcoming the effects of these very highly sensitive heat exchangers where there is a tendency to undershoot and overshoot. It may be the answer, to position the control point of your temperature controller by a viscosity-sensing instrument.

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SPRAY LUBRICATION OF OPEN GEARS

By JOSEPH A. RIGBY
Vice President
Brooks Oil Co.
Pittsburgh, Pa.

JOSEPH A. RIGBY

. . . . spray lubrication is the most practical and economical method which can be used for open gears . . . .

▲ WITH the advancements in engineering designs of increased substitution of enclosed gears, direct drives, V-belts and possibly other mechanism as may be indicated for open gears, it must be acknowledged, that open gears are a vanishing or a diminishing practice. Although this is true, there are thousands of open gears, which will be in continued use for many years to come. This is necessary because of extremely high costs for substitution and because of economical operation from good maintenance practice. Open gears are also being used on new equipment being manufactured today such as presses, shears, hoists, overhead traveling cranes, locomotive cranes or shovels, paper mills, sugar crushing mills, cement and ore fusing kilns and numerous types and designs of specialty machinery. This practice prevails because of prohibitive costs for enclosing, competitive price comparisons, location of gears, such as on top of presses where a safety hazard is not created, and in conditions where gear enclosures would cause lubricant contamination with water, abrasives and other substances. In other cases, there are inadequate clearances which develop conditions where it is impossible to use guards or enclosures. There are also many designs where a metal guard or enclosure is provided, but of such construction that oils or fluids cannot be retained from lack of seals or tight joints. This condition develops requirements such that the classification has to be that of open gears in the application of lubricants. Considering the fact that open gears will be in use for many years, and that they probably never will be entirely eliminated, a problem is present which will continue to exist in requirements for the most efficient methods of lubricant application.

Open gears may be of cast teeth, cut teeth, flame hardened or alloy material and heat treated. The teeth may be spur, staggered, helical, herringbone, worm or special in types. Progressively, the cost increases and thus demands the utmost in protection against frictional drag, noise and wear.

In the history of open gear lubrication, the first products used were probably animal and vegetable fats with evolution to animal, vegetable and petroleum oils, then to saponified oils and greases. Some authorities establish the use of the compounds and greases at approximately sixty-five years ago. With the advent and progress of the steel and other heavy industries, there was imposed the problem of increased loads and speeds.

Figure 1 — The portable spray unit shown consists of a spray gun with 10-in. extension which is mounted in connection with a diaphragm operated air cylinder. Unit has 5-lb capacity.

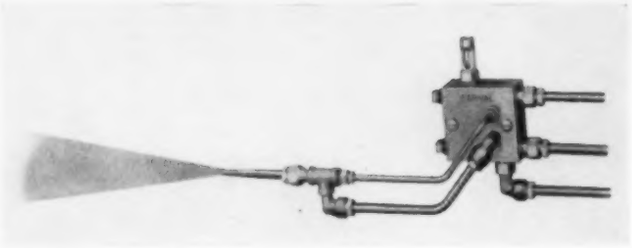


Figure 2 — Equipment shown is a spray valve which has a flattened tube for a nozzle.

This developed improved gear lubricants of resinous pitch and tar compounds with high adhesiveness and heavy film characteristics. Progress in the petroleum industry next produced residual compounds low in cost, of higher film strength, and in general, of better lubricating qualities. Technological progress next developed extreme pressure greases for the rapidly increasing demands created by increased tooth loading, shock, prevalence of water, corrosion and other factors contributing to gear wear. Recent developments have been that of solvent cut-back specialty open gear lubricants. These have base material compounding for extremely high film strength, and adhesiveness together with other desirable characteristics in protection against wear of gears.

Methods of application have been that of dripping, dipping, pouring, brushing and swabbing. These have all had disadvantages in throw off, drippage, lack of uniform distribution, requirements in heating, excessive consumption, and expenditures beyond an economical standard in clean-up and disposal labor.

About fifteen years ago, the idea originated of spraying open gear lubricants. This probably developed from the successful spray applications of paints and roof coatings. From the beginning, this method met with favor, and particularly so in the steel industry where open gears were so numerous and the lubricating problem one of great magnitude and expense. The first grease spray equipment had air pressure for the feeding and atomizing medium, but the equipment was of a bulky nature. Credit must be given, however, for this innovation, as some of this original equipment continues in use today. Gradual but intensive interest stimulated the manufacturers of lubricating equipment to develop simple, light weight, portable spray equipment suitable for almost any open gear condition or location and with excellent distributing and servicing organizations. A point of caution must be observed, in that the lubricant has to be one with suitable characteristics for spraying. This latter point need not be of serious concern, as the manufacturers of lubricants have kept pace and can supply the correct type and grade of products for satisfactory application and use.

The spray equipment now available has been carefully designed for various conditions dependent on the number of gears to be lubricated, location, facilities available, and frequency of application. To classify is difficult, but some description can be submitted for guidance in choice.

For a small plant with a few gears, and where it is feasible and safe for workmen to be close to the gears, a simple and satisfactory method can be used. This is to use an ordinary hand pressure grease gun by removing the check valve in the outlet connection and substituting a pipe nipple with a pipe cap on the end. In the center of the cap, a hole should be drilled of approximately one-eighth of an inch diameter. This has been successfully used and forms a good pattern, but the lubricant will be applied in somewhat globule form from which the meshing of teeth distributes the product in the form of a film.

With an increase in plant size and gear numbers, there are available hand operated portable containers of 20 to 25 pounds capacity equipped with a hand pump, hose and spray nozzle. Applications can be made in a good pattern without the use of air pressure and the equipment is easily operated and moved by one man.

Improvements available include several designs of air operated spray equipment in capacities from 5, to 25, 40, 50, and 100 pounds and up to a full drum of 420 to 440 pounds. These are all of portable type with the smaller sizes easily carried by a workman, and larger types moved on dollies or other means. The lubricant can be forced from the container to the hose and spray nozzle by air pressure alone, with an intermediate diaphragm between air and lubricant, or by means of a barrel or drum pump on the container. The latter is usually air operated, but other methods could be used. In addition to the spray nozzle and the lubricant hose, another air hose for nozzle atomizing is required.

Another successful method used consists of a drum located in a heated building with a system of piping extended over the locality where the gears are located. A drum pump is used as the pressure medium to force the lubricants through large size piping to the points of use. As piping calculating tables for flow are based on water or air, an ample allowance by increase in pipe size must be made for lubricants. This is necessary because the inherent stickiness of the lubricants cause heavy thickness applications to the inside of the piping which restrict the flow and develop excessive pumping pressures. With such installations, a hose connection is provided at frequent points so that coverage can be made to all gears by moving the hose from one point to another. A spray gun with an air hose is provided, and the drum pump operates only during the period of time in which the gears are lubricated.

While not exactly a new method, one which has recently developed sufficient favor so that equipment manufacturers now offer and promote it as an efficient and labor saving method of lubricant application consists of an automatic pressure system with a timing device, and a piping distribution system with individual sprays located close to the point of mesh for each pair of gears. With this method it is possible to develop a reasonably good spray pattern with a nozzle only, but the customary practice is to use an atomizing nozzle with air pressure. The atomizing feature is preferred for pattern and also aids in keeping the nozzle orifices open during intermittent operations. For large gearing projects where piping is not objectionable, where high temperature and other factors require frequent applications, or in locations inaccessible to workmen, this method offers splendid opportunities for improving gear lubrication for many installations. In general, there is believed to be a feasible method, with economical ad-

vantages, in the use of equipment for spray lubrication of all open gears.

Equipment for spray lubrication is one factor, but another is the choice of the lubricant. Available are various types, and it is certain that one exists for every application with the choice governed by conditions or circumstances. Fluids or oils may be preferred and are an easy problem in spraying, but frequency of applications, throw off and the problem of clean-up or wastage, leads to avoidance. Some cases exist where necessity or preference for oils prevail so the subject cannot be avoided. The most desirable product would be one having fluidity, adhesiveness and thin film, but high film strength. Advantageous would be light fluid grades with ease in pumpability, smaller piping, low temperature usage and better spray pattern. Solvent cut-back compounds in the lighter grades have all of the desirable characteristics and offer opportunity for the use of fluids without excessive throw off or drippage. Tests and experience have proven the feasibility of using grades up to 750 S.S.U. at 210 F in pressure pumping systems at ambient temperatures of 75 to 80 F.

In grease application, most authorities agree that the product should be of extreme pressure type, however, consistency is also an important factor in spraying. To spray grease is not a difficult problem except that the pattern will not be all that can be desired. As a result, the film coverage must be made by the teeth contact as the spray distribution will be in the form of rather large globules of varying size. This tends to excessive drippage and throw off of an objectionable nature. Consistency must not exceed No. 2 N.L.G.I. Cup Grade or 325 A.S.T.M. Minimum Penetration at 77 F for existing spray equipment.

With the availability and advantages of solvent cut-back open gear lubricants, with base material compounding for extremely high film strength and adhesiveness, no serious difficulty has been encountered within limitations of viscosity or possibly penetration. Based on present practice in the normal temperatures of the temperate zone from May 1 to October 15, the viscosity used should not be over 1000 S.S.U. at 210 F, and methods should be used to approach or maintain this during the other periods of the year. This involves heating consideration which will vary in design or construction, dependent on conditions of clearance, building enclosures, and other factors. In all cases it can be worked out, usually with steam companion piping or electrical strip and resistance wire heating elements. Objections may be raised, however, that recognition must be made for the short range from the low to the high temperature limitations for all petroleum products and compounds. Installations should be made to avoid heating requirements, but many cases will exist where it is indispensible. Care must be exercised to prevent excessive heating which can decompose lubricants and clog the distributing piping, fixtures and other parts of spray equipment.

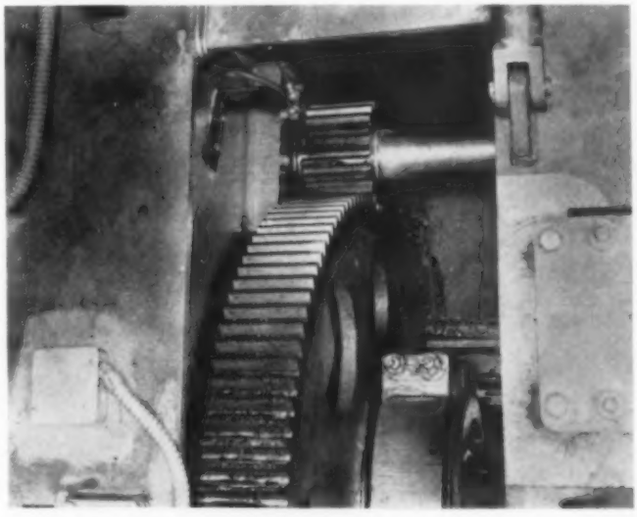
The subject of equipment could not be complete without some description of the spray guns and nozzles. There are several types and designs somewhat similar, but probably all of revised paint or roof coating type converted to the use of lubricants. These must be light in weight and easily handled by workmen. Some spray guns are short or stubby, but it is believed that superiority can be claimed for those designed with extension piping from the gun body of from 10 in. up to several feet in length. With such design, atomization is in the nozzle with control at the gun handle. This type permits the operator to use the extended nozzle as a pointer to correctly aim and place the lubricant for application to the teeth only and thus reduce wastage. Other advantages are easy application of the lubricant to overhead gears, application through openings in guards or enclosures, and to remote points not accessible to the operator. Such equipment also supports the statement that gears can be safely lubricated while in motion as the operator can be in a position remote from the gears with no hazards involved.

The nozzles should provide a pattern either in the form of a cone or flat and fan shaped. Orifice size will be determined by the lubricant used, which in the case of oils or fluids is usually $\frac{1}{32}$ to $\frac{1}{16}$ in. in diameter. With grease or plastic lubricants and the solvent cut-back types, the nozzle orifice must be of increased diameter. Successfully used are diameters from $\frac{1}{16}$ to $\frac{3}{16}$ in. The size of orifice must be determined from various factors such as consistency, temperature, desired pattern and possibly others. A proper size can be attained as experience has proven the feasibility, although some experiments may be necessary to produce the desired results, particularly for the pattern of the spray.

Spray lubrication of open gears can be claimed to be superior to any other method. The following are some of these advantages:

1. The lubricant can be used from the original container or transferred to other containers without the possibilities of contamination, spillage and open container handling.
2. A point pattern applies the lubricant where required on the teeth surfaces with negligible necessity for film coverage by teeth contact.
3. The point pattern permits application to the teeth of only the exact amount required. This eliminates throw off, drippage and lubricant deposit where not required.
4. Control to minimum requirements reduces clean-

Figure 3 — The spray nozzle shown in Figure 2 is shown here lubricating the gears of a press.



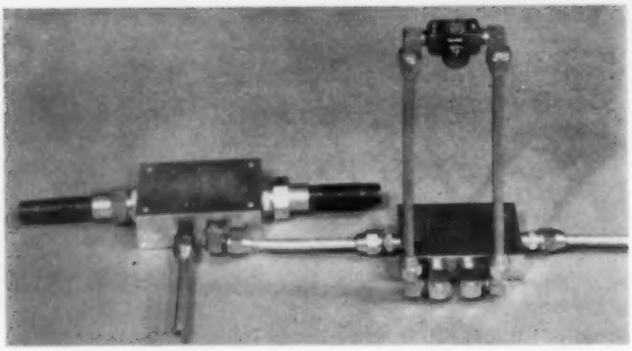
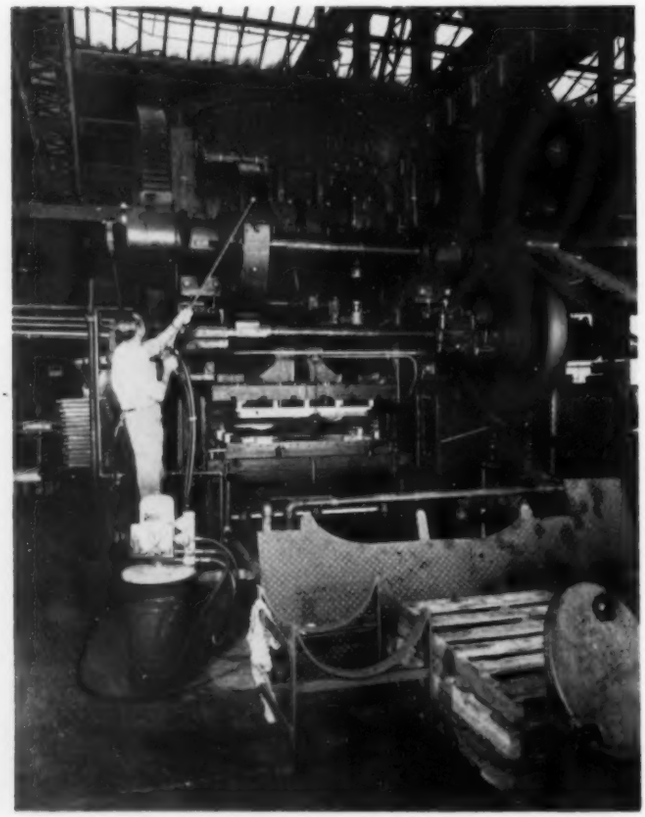


Figure 4 — The spray valve illustrated is used with a reversing lubricating system.

up labor, and the fire hazard inherent with excessive accumulations of used lubricant.

5. Frequent applications can be easily made. This is particularly true where gear temperatures are excessive for lubricants, or in cases of temporary misalignment of gears, causing point contact instead of the desired line contact with rapid wear to the teeth.
6. Gears can be sprayed while in motion or stationary in a safe manner as the operator will not have hands, clothing or any parts of the body close to or exposed to the inherent dangers of meshing gears and rotating mechanism.
7. Economies to be gained are of such value that advantages should be offered for practically all open gears, but emphatically so where large numbers are in use. These economies are in better film coverage, elimination of heating for shielding type lubricants, reduced lubricant consumption, and reduction of clean-up labor and disposal costs.

Figure 5 — The use of a long extension on the spray gun enables lubrication of spots otherwise relatively inaccessible.



Some difficulty has been encountered from objections by labor because of application from bulky or cumbersome equipment, air hose handling and the more exacting application requirements than with methods formerly used. In no way can this be recognized as unfavorable reflection to the spray method. It is possible of some correction in the selection of equipment and remains a supervisory responsibility in educational methods, training and observance.

Credit must be extended to those responsible for the developments in spray equipment and suitable lubricants for application with this method of open gear lubrication. This has required extensive studies to be made, designs revised, experiments conducted, problems investigated, research established and data submitted by technical papers. In addition, field demonstrations, advertising, solicitation and other actions are used to acquaint those having open gears with the advancement and advantages of spray lubrication. These activities have been of costly nature, but are believed to be justified from the confidence in this logical method. To a large extent, this has been accepted as the most practical and economical method which can be used for the lubrication of open gears.

DISCUSSION

PRESENTED BY

CHARLES A. BAILEY, Chief Lubrication Engineer, National Tube Co., Pittsburgh, Pa.

DONALD E. WHITEHEAD, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

W. H. MANDY, Lubrication Engineer, The Texas Co., National Sales Div., Pittsburgh, Pa.

JOSEPH A. RIGBY, Vice President, Brooks Oil Co., Pittsburgh, Pa.

WALTER H. HODSON, The Hodson Corp., Chicago, Ill.

V. G. GREEN, Development and Sales Dept., Binks Manufacturing Co., Chicago, Ill.

E. J. EHRET, Farval-Cleveland Worm & Gear Co., Chicago, Ill.

WILLIAM FATCH, Lubricating Engineer, United States Steel Co., Gary, Ind.

ANDREW CICHELLI, Lubricating Engineer, Bethlehem Steel Co., Sparrows Point, Md.

Charles A. Bailey: Spray lubrication of open gears as a method of application is practical; however, the practice has not been adopted as extensively as might be expected.

A possible reason for the slow acceptance could be the wide selection of spray equipment, such as hand guns, portable units, stationary units, additions to centralized systems, etc. All of this equipment incorpo-

rates various designs of spray nozzles and requires a certain amount of adaptation to the individual lubrication problem. Therefore, to make progress the subject must be reviewed periodically to allow each new improvement to take its place in the record.

The design of spray equipment is important in the progress of spray lubrication. It should be developed simultaneously with the lubricant to be sprayed. In this connection it is generally agreed that a spray lubricant should have good extreme pressure characteristics such as are evaluated normally by the following procedure or its equivalent:

TIMKEN LUBRICANT TESTING MACHINE
TESTING PROCEDURE — ONE POUND GUN METHOD

The Timken test cup and block are washed with a petroleum spirit and dried prior to assembly. The cup and block are coated with the sample lubricant upon assembly. Care should be exercised in adjusting the aluminum grease guard and lever arm, also in tightening the test cup to avoid distortion or misalignment.

A one pound hand gun is completely and uniformly filled without air pockets or voids and screwed in a vertical position into the pipe tee of the lubricant supply line. This tee connection supplies grease in place of fluid lubricants to the test cup and block assembly of the testing machine.

The test is started by first checking and adjusting the motor speed to 800 rpm, then simultaneously checking time, applying grease and applying the lever arm load. The load is applied by an automatic loading device. The grease is applied by turning the hand screw of the grease gun as uniformly as possible over the ten minute test period. The flow of grease through the machine is guided with a spatula into a container at the open end of the aluminum guard.

At the completion of the test run, the machine is stopped and the test block removed for inspection and reporting of the following data:

O.K. Load — A test block scar with straight line sides and no metal pick up.

Critical O.K. Load — A test block scar with straight line sides but slight metal pick up within the scar.

Failure Load — A test block scar with metal pick up causing the boundary lines of the scar pattern to be irregular.

The test procedure is repeated with new sample until an O.K. load and a failure load is determined.

It has been found by field trial that two lubricants rated equal by the preceding method did not produce the same operating results. It appeared that there should be a test more nearly simulating field conditions, in which a measured amount of lubricant would be applied and the evaluation made by the time recorded from start to failure. Therefore, the following procedure was established:

TESTING PROCEDURE — FOUR GRAM METHOD

The Timken test cup and block are washed with a petroleum spirit and dried at room temperature prior to assembly. Care is exercised in adjusting the aluminum grease guard, lever arm and in tightening the test cup to avoid distortion or misalignment.

Four grams of grease sample are weighed on a watch glass to the nearest 0.1 gram. The entire amount is applied by spatula to the bearing surface of the test cup and block. The lubricant testing machine is rotated in the operating direction by hand until the excess grease on the test cup has been removed by the test block over the entire width of the test cup which assures perfect alignment.

The test is started by simultaneously checking time and applying the lever arm load by means of an automatic loading device.

The test is stopped by any one of the following observations indicating a failure point:

1. Appearance of the lubricant film on the test cup. (A line break in the film indicates approaching failure 200-300 seconds prior to destruction of the entire film).
2. Machine chatter caused by dry metal.
3. Smoke, overheating, or sounds that indicate dry metal pick up.

The datum reported is the total time required for failure to take place.

This procedure currently applies only to gearshield type lubricants used for spraying open gears or the equivalent. The test is run under a 43 pound lever load at 800 rpm.

Donald E. Whitehead: It is my feeling that the subject of application or methods of application to steel mill equipment is lagging behind the quality of the lubricants that are available. Tremendous strides have been made insofar as the lubricants themselves are concerned, but I still have visions as far as application is concerned, of an oiler walking around with an Aerosol lubricant bomb in one hand and some lubricant capsules in his pocket which he can drop into the mesh of whirling gears. That may sound far-fetched, but is worth thinking about, because I believe that in shops where the gears are lubricated at infrequent intervals we have been handicapped in application methods and the subject of spraying has been deterred because we do not have simple instruments for applying the spray. Lubricant spraying probably reached a high interest and climax about four or five years ago, and big strides were made in developing both equipment and lubricants.

W. H. Mandy: In order to completely realize the economy of spray lubrication and overcome any reluctance on the part of the operating personnel to adopt this method of application, it is of utmost importance to select spray equipment to suit the particular job at hand. If the spray equipment selected can be used with less manual effort than the prevailing method of open gear lubrication, it is reasonable to expect that the spray equipment will be used.

Permanent installations usually involve higher initial costs but are quite readily adopted by the operator. In many cases, however, permanent installations are not feasible and completely portable or semi-portable spray equipment must be adopted. It is in these instances that the equipment must be simple and easy to operate.

The author seems to prefer air atomization at the spray nozzle, and I certainly concur, not only for the reasons mentioned, but also because it permits the application of a thin film of lubricant which is difficult to

obtain otherwise. I think this is particularly true when using cut-back lubricants containing a diluent, where excessive throw off and high consumption will usually result if thick films are attempted.

With the use of solvent cut-back compounds, the author states that tests and experience have proven the feasibility of using grades up to 750 SSU at 210 F in pressure pumping systems. In the next paragraph he states, and I quote, "Based on present practice in the normal temperatures of the temperate zone from May 1 to October 15 the viscosity used should not be over 1000 SSU at 210 F." I would like to have Mr. Rigby clear up the point as to which of these viscosities is preferable.

Referring again to solvent cut-back compounds, I presume the author has reference to the non-inflammable type of solvent in order to avoid the possibility of fires.

Regarding the choice of lubricant, the author stresses high film strength in addition to fluidity, thin-film, and adhesiveness. I am inclined to put the greater emphasis on adhesiveness, more so than high film strength. The term high film strength is frequently loosely used. I would like to ask Mr. Rigby to explain whether he prefers high film strength of extreme pressure characteristic or high film strength derived from the use of polar agents or other oiliness agents.

Joseph A. Rigby: Mr. Mandy's point concerning viscosity is well taken. In my paper I did not emphasize very clearly what I meant when I spoke of 750 SSU viscosity at 210 F, but I had reference to the automatic systems as these are commonly used today. In our experience we have found that this is the limit we can go to for good pumpability. I had reference to 1000 SSU viscosity at 210 F for spray guns which are manually operated. It is possible in practice to use up to that. I do not know of any experience with viscosity over that, which seems to be about the limit for normal weather conditions. If it is cold, it usually is the practice to go down to 750 seconds unless there are provisions for keeping the lubricant warm.

As Mr. Mandy pointed out, film strength and adhesiveness are very important. He is correct, too, in that adhesiveness is the most important point, but I believe it is generally recognized by all that in open gears it is very difficult to keep good alignment, and in some of the older mills you will see bevel gears which should have line contact but which actually contact only on the point of the teeth. Naturally the higher the film strength of the lubricant, the more protection is offered to prevent wear on such small contact areas. That is one of the problems we meet today and emphasizes the advantages of extreme pressure lubricants.

Then we have the matter of overloading of gears. The plants that were built twenty-five years ago or more and are still in operation have gears overloaded to a great extent from present day production demands, not only in reduction factors but from hard and tough materials. This is particularly so in some of the metallurgical items and alloy materials such as stainless steel or any chrome alloys, corten, nickel steels and various others of that nature. Commonly called to attention are gears that quickly pit even in some new installations. These are invariably operated at beyond the designed load capacity. It is my personal experience and belief that all gears should be lubricated with an extreme pressure lubricant. This has a decided advantage today, and the cost is not too much out of line for added protection for long service.

In covering the subject of film strength, I believe there is another factor of value in the 4 gram test to prove the enduring nature of the films. I think the test is more highly indicative of that than anything I know of, and we as a company have employed it for testing the gear lubricant film strength. Mr. Walter Hodson, president of The Hodson Corp., first introduced spraying about fifteen years ago with spray guns. We have progressed somewhat since then, but I think we should hear what he has to say on this subject.

Walter H. Hodson: In discussing the above subject, Mr. Rigby has had to cover a very large field brought about by the evolution of machine tool design from the water wheel to the modern turbine. We now find any number of combinations to be considered or confronted with in the spray lubrication of open gearing.

The greatest evil, as observed in our field activities, is brought about by the fact that in most cases the lubrication of open gearing is a secondary matter, and if demands were not made for better housekeeping, safety, reduction in maintenance, little, if anything, would have been done about it in our time. Production has been so paramount in most of our endeavors, that gearing just went along clanging and banging to the tune of all sorts of lost dollars.

Our modern means and methods of basic lubrication formulation in connection with the mechanical equipment involved, plus our modern designed spray systems, have changed these negative and adverse comments.

We believe that if serious thought can be given to the selection of equipment, diligent study made of the requirements, and practical selection is made of the lubricant, that an ideal condition can be obtained where truly "the mechanics of lubrication engineering" can be practiced, thus resulting in savings in operation, maintenance, lubrication and housekeeping costs.

V. G. Green: I would like to say a few words about the differences in nozzles. We manufacture nozzles for practically every purpose, and therefore, we know something of their characteristics and limitations.

There has been some discussion, and it was also brought out in the paper relative to the spraying of lubricants without air, that the nozzles used for that purpose are usually designed to spray materials of thin viscosity, such as water, light oil, chemicals, etc. It is quite difficult to control the amount of materials with nozzles of this type, such as you want to do when lubricating gear surfaces. If you use a heavy lubricant with a nozzle of this type it is simply extruded from the nozzle. You could just as well use a piece of pipe flattened at one end. In many cases it is impossible to apply this lubricant directly at the point of contact of the gear teeth. As a rule the lubricant will just lay on the gear surface without adhering, and if the gears are travelling at a considerable rate of speed, the lubricant is thrown off before the teeth have a chance to mesh.

We have developed nozzles for the purpose of lubricating open and semi-enclosed gears. Compressed air is used, and the air and lubricant are mixed within the nozzle head. In this manner the lubricant is atomized into particles of varying sizes, from $\frac{1}{16}$ to $\frac{1}{8}$ in. in diam. These particles are thrown onto the gears with such

velocity as to cause the particles to flatten and adhere to the gear surfaces until the teeth have had a chance to mesh.

Nozzles of this type are simple in construction and easily installed. They are usually permanently located right at the point where the lubricant is applied. The lubricant is supplied from a central location usually from the drum in which the original shipment was made. Standard lubricant pumps of the air operated type are mounted in the shipping drum from which pipe lines lead directly to the nozzles located at the gears to be lubricated. There may be one or several of these nozzles in each location, depending on the size and shape of the gears.

This lubricant pipe line is usually paralleled by an air line, or at least air is brought to the point where the lubricant will be applied, and both air and lubricant may be controlled by ordinary valves. These valves may be manually operated or they may be solenoid valves operated by a hand switch in some convenient location. After the frequency of lubrication and the amount of lubrication has been determined, time switches may be used, which entirely eliminates the human factor.

With such an arrangement where lubricant is always under pressure, it is only necessary to open the valves admitting both air and lubricant to the spray nozzles to start the pump in operation. Nozzles of this type provide adequate lubrication in the proper amounts and in the interval of time required, thus effecting a great saving in the amount of lubricant used, wear and tear on the gears, and the elimination of hazardous conditions in the vicinity of the gears being lubricated.

E. J. Ehret: Mr. Rigby emphasized the availability of the numerous lubricants and various hand methods of applying lubricants to open gearing, but did not emphasize the fact that automatic devices are available for this purpose. My company started the manufacture of centralized lubricating systems for bearings back in 1927 and now they have developed a centralized spray lubricating system for open gears.

In other words, it is now possible to install a complete spray lubricating system for all the open gearing on a complete mill table in the same way we provide a centralized lubricating system for the bearings. As a matter of fact, where a system is lubricating the mill table bearings already, they can now add the spray valve equipped with any standard nozzle and lubricate all the gears and all the bearings at the same time. When this combination system is installed, some thought should be given to using a dual purpose lubricant which we understand from many major vendors is now available.

On a number of spray lubrication jobs where open gearing on mill equipment is being served, previous to the installation of the automatic spray equipment, it was found necessary to shut down and inspect the gearing each week, in order to detect wear and allow for replacement of parts resulting from the inability of the operator to do a satisfactory job of applying lubricant by the unsatisfactory methods available. This weekly inspection has now been dispensed with as a periodic checkup indicates that such lost time is unnecessary, due to the satisfactory and complete lubrication job being done by the automatic spray equipment. On this particular application, the gears are relatively close to a large mill stand where heat, salt water and dirt made it impossible for a man to do a satisfactory job of lubrication by hand methods.

Other installations have been put on slides, racks, as well as mill drive open gearing. The pattern we get from our spray valve system is approximately 6 to 8 in. in diam. Therefore, we can take care of a gear with that face. Of course, if we get to a 10, 12, 14 in. gear or larger we have to go to two such valves.

This particular application indicates clearly that the former lost production time and high mechanical failure factor of gearing was due solely to lack of lubrication, and since this source of trouble has been eliminated by the application of automatic spray equipment, operations can go on indefinitely without the necessity of periodic shutdowns for inspection.

The speaker touched on the difficulty of handling lubricants in cold temperatures, and in this respect we believe that the actual problem involved is too often overlooked in the conclusion that the limitations of the spray valve or the pumping equipment are the determining factors in how heavy a lubricant can be handled at low temperatures.

Actually, our valve with its large openings and passages will handle any lubricant that can successfully be conveyed through a pipe. The problem, therefore, is not what will the pumping equipment or the measuring valve handle, but what can be pumped through the pipe, and the problem here is no different than in any centralized lubrication, and the remedy for any troubles encountered from this source are the same: namely, heating of the supply pipes by use of steam tracer lines or hot bed cables where temperature conditions below the point at which the lubricant will flow are encountered. We should not lose sight of the fact that many of the so-called gear lubricants are compounded not to meet the requirements of the gearing, but rather to overcome the shortcomings of the method of application. It seems probable that with reliable methods of application available, the lubricant manufacturers will turn their attention to the fundamental problems of lubricating the gears rather than merely coating them. The results of such exploration should be increased gear efficiency, reduction in power, and I believe, automatically the problem of handling gear lubricants will disappear.

Another fine application was on an 8-in. diam, 40-ft screw on a pipe flash trimming machine where we installed about six spray valves along the 40-ft length, and as the screw passed by, it was lubricated every time by the system shot which was on about a 15-min basis. On this machine, in addition to lubricating the screws, we lubricated about 275 bearings on the machine with the same lubricant and it has been in service over a year with phenomenal results.

Several press builders have incorporated two spray valves right into the manual system lubricating the bearings on presses, and when the operator operates the manual compressor or if it is an automatic system, when the time clock starts the system, you lubricate the bearings and at the same time give the gears a spray of lubricant.

Tests were made in the press manufacturer's plant to see if a once every eight hour application was suffi-

cient to keep these gears lubricated, and this has proved to be so in a number of installations, and it eliminates the need for someone to be climbing up on top of the press.

With the advent of the open gear spray lubricating system, we can accomplish the same thing for open gear lubrication as we did for multiple bearing lubrication.

Due to the high tension and need for maximum production, this system has not caught on as fast as centralized lubricating systems did for lubricating bearings, but we feel sure it will as soon as the plants have time to do it or when they realize that scarcity of material will call for more attention to this device.

William Fatch: Now, as I see it from the experience in the last five or six years, spraying in the summer is very satisfactory. Now we have sprayed with the five-pound container and the one hundred-pound drum pumped with a hand spray and also with a stationary 450-lb drum, but when it comes to spraying in winter in the cold weather, and, as you know, our steel mills are just as cold on the inside as the outside, we always have to stop our spraying in the wintertime. We have had one installation where we had a drum and the pump in a barrel in a heated container. We had, I would judge, about a thirty or forty foot hose, and when we tried to spray the grease, it would hit the cold hose and we could not get any spraying effect. It would just drop off the end of the nozzle.

Mr. Rigby was talking about having steam lines and electrical lines follow your pipelines. Now, in a steel mill in the motor room that is not very practical, because if you have a breakdown the first thing maintenance men do is to pull or jerk the covers off and then your equipment is ruined. Right now we have one of the lubricant manufacturer's centralized practical lubrication systems on the train of the gears in one of our bar mills, and thus far it has proved very satisfactory, but what it will do when the cold winter weather comes we do not know. We are trying two different types of lubricant, and, as I said before, what is holding us back is the spraying of the lubricant in cold weather. It is not the device, it is the lubricant in cold weather.

As far as the spray systems built now and the spray nozzles, we have found that with just an ordinary piece of pipe as a nozzle, it will give us just as good a pattern as a real expensive nozzle. Of course, we are not in that business so we like to patronize the nozzle people as well as the lubricant people, but I think that the lubricant manufacturers should work on this a little more thoroughly in spraying in real cold weather.

Andrew Cichelli: Mr. Mandy posed a very important question, and I believe that Mr. Rigby was perfectly correct in saying that adhesiveness, in his opinion, is more to be stressed than any other property of a lubricant. However, the issue that was raised was, do we or do we not need extreme pressure for open gears. In my opinion, a case can be made for the non-necessity of extreme pressure products on some applications. It was stated that often in assembly of gears, there is misalignment, and therefore one is practically forced to employ an extreme pressure lubricant to protect one's self. We spray open gears, making use of both types, and it is our feeling that there is a place for each.

There is one factor in this discussion which I think is probably the overriding determinant of the whole problem. I refer to the material and treatment, or the metallurgy of the gear itself. Assuming the gear is designed so that the gear tooth itself has ample beam strength, it does not mean that it will not wear even with an extreme pressure lubricant.

A gear should be designed not only with ample beam strength, but ample wear characteristics, which can only be provided by proper material and treatment. If that is the case and if our maintenance people do their job during assembly, there is no place for an extreme pressure lubricant. On the other hand, there are applications where even if all the conditions were fulfilled, gears are loaded above their original design limitations, in which instance an extreme pressure lubricant must be used.

Since our plant has open gear applications in which both extreme pressure and non-extreme pressure compounds are used successfully, we believe we are justified in stating that there is a place for both types.

Joseph A. Rigby: I would like to answer the question by Mr. Fatch on cold weather lubrication. I cannot really answer it, but just want to ask if you know of any lubricant that you are using in the steel mill industry that is not a problem during cold weather. All we can do is attempt to keep types on hand which are suitable for open gear lubrication in cold weather, however, some method of heat is necessary to maintain constant viscosity or consistency.

I happen to be with a company manufacturing lubricants in which we advertise and promote the solvent types for open gears and claim that these do not require heating. These are used to replace shielding type of lubricants which are not desirable because of heating requirements for application. In the use of these solvent cut-back lubricants for spraying open gears during cold weather, we find it only necessary to keep the containers in an oil house or other building where a method of room heating is provided. A temperature of 70 F is usually sufficient, however, these buildings are usually 80 to 90 F.

Incidentally, the biggest problem I have found in spray lubrication is that of labor and maintenance. It is most difficult to get men to carry the equipment around, but this can be worked out in education and supervision.

In answer to Mr. Cichelli's question, we are usually called on for troublesome conditions, so for that reason are limited to specialty lubricants. It has been our experience that where trouble exists from gears not properly aligned, that extreme pressure lubricants are a possibility for correction if mechanical changes cannot be made. Probably the most important factor in gear wear is overloading, but what can you do to stop it? It is usually a production demand. What can you do to get new materials? They are not going to give you the opportunity for improved equipment, so you have all these problems to face. We think that improved lubricants offer many advantages without excessive costs or an increased inventory of lubricants. As a matter of fact, the proposed lubricants can be extended to many other services because of the versatile characteristics.

The Electrical Laboratory IN A STEEL CORPORATION

By W. A. BLACK
Chief Electrical Engineer
Steel and Tubes Div.
Republic Steel Corp.
Cleveland, Ohio.

. . . . an electrical laboratory provides an excellent avenue of determining soundness and other characteristics of the product for the manufacturer . . . .

▲ ALTHOUGH the title of this paper refers specifically to "Electrical Laboratory Service," the work might be more accurately described as "Laboratory and Engineering Service." It is sometimes hard to draw the line between laboratory and engineering work, especially when both of them are closely integrated into production operations as in the case of the department to be described. The subject was chosen because of the feeling that there is much to be gained throughout the entire steel industry by wider use of this type of service. A description of some of these activities may stimulate ideas that can be used in other organizations.

The department which provides this service includes a number of project engineers to whom projects are assigned in accordance with their areas of specialization. For instance, one man specializes in induction heating, another in x-ray applications, another in ultrasonic testing. Others have had long experience in other methods of non-destructive testing, design and construc-

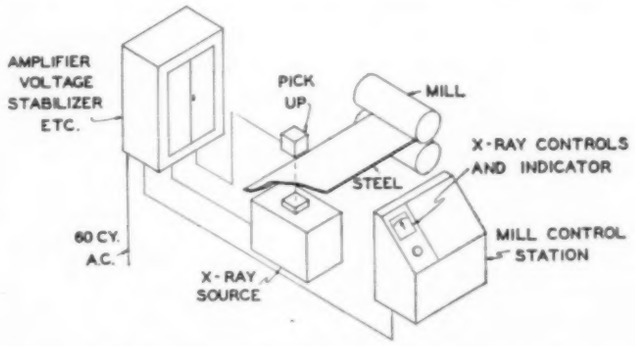


Figure 1 — X-Ray thickness gage. Amount of x-ray passing through strip is used as a measure of the thickness.

Figure 2 — This x-ray thickness gage is installed on a 98-in. hot strip mill.

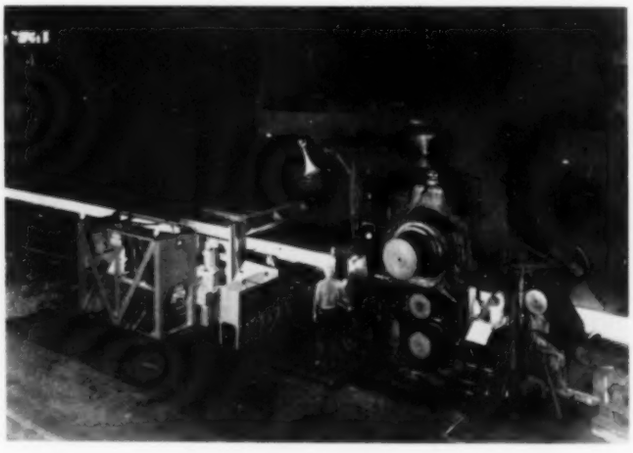
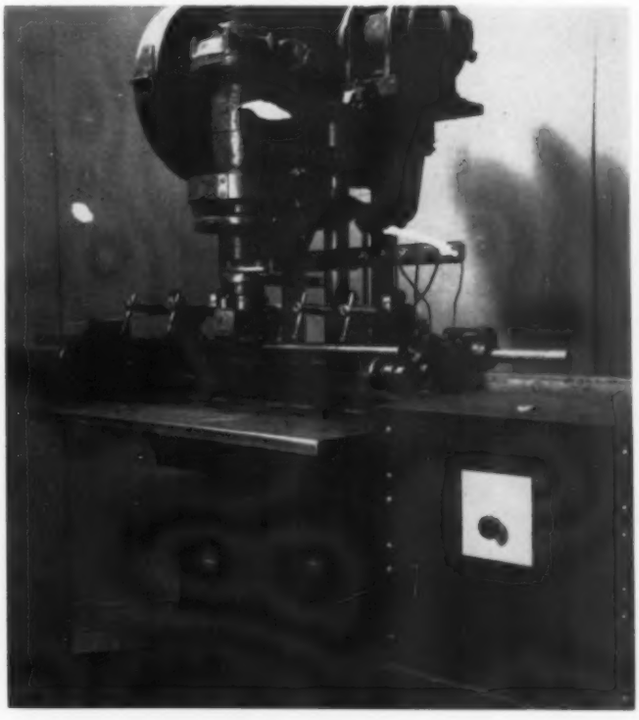


Figure 3 — Rejectable tubes are indicated by lights on straightness indicator.



tion of automatic control systems, applications of resistance type strain gages, etc. These men serve all districts of the corporation and provide a background of experience and special training that individual plants could not afford.

Projects to be discussed may be grouped as shown below. Typical savings from these projects are also listed:

Group	Savings in
I. Dimensional Gaging by Electric Instruments	a. Customers' claims and complaints b. Off-gage product c. Inspection labor d. Operator fatigue and associated errors e. Manufacturing costs f. Unnecessary rejects
II. New Methods of Electric Welding	a. Welding labor b. Worn parts by reclamation c. Production time d. Reduced weld rejections e. Raw materials f. Customers' claims and complaints
III. Induction Heating	a. Fuel costs b. Production labor c. Furnace maintenance d. Product appearance e. Floor space required f. Cleaning expense, both in product and building
IV. Electrical Devices for Preventing and Sorting Mixed Analyses	a. Customers' claims and complaints b. Testing and inspection labor c. Machine failures due to wrong material d. Processing of wrong material
V. Non-Destructive Detection of Defects	a. Customers' claims and complaints b. Inspection labor c. Expense of producing defective products d. Production delays e. Machine work on defective parts f. Accidents due to machine failure in service.
VI. Automatic Controls	a. Labor, production and maintenance b. Quantity and quality of production c. Operator fatigue d. Handling e. Human errors f. Machine and product damage
VII. Resistance Strain Gages	a. Errors in design b. Machine breakage c. Errors in weighing d. Production delays e. Engineering time f. Mill setup time and other labor

The services rendered by laboratory personnel in connection with these varied projects range from investigation of new commercially-available instruments through simple testing, consultation and standardization to original design, development, construction, installation and maintenance. The amount of service required in a district depends to a considerable degree on the facilities and personnel available in that district. Incidentally, it might be of interest to know (if you have not already acquired the knowledge from your own personal experience) that the most difficult piece of equipment to handle in this work is "people." This branch of engineering needs a lot of attention.

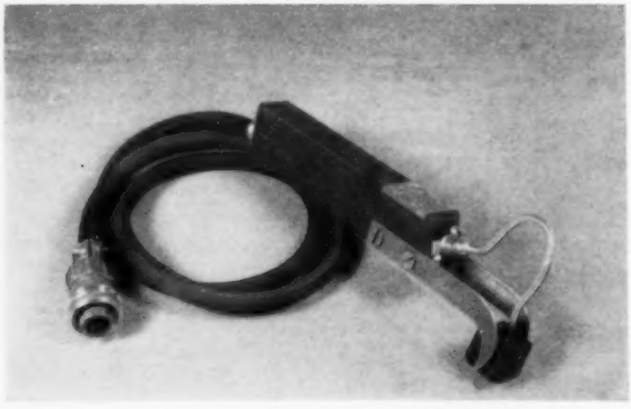
DIMENSIONAL GAGING

The first phase of activity mentioned above was dimensional gaging. One of the most interesting and most productive items is gaging for thickness on a hot strip mill. The method used is passage of x-rays through the steel. Figure 1 illustrates the basic idea. Figure 2 is an installation on a mill. Several manufacturers are now producing gages for this purpose and it has taken considerable study to evaluate the merits of the various systems used. However, regardless of the system used, x-ray gaging is undoubtedly the most important advance in hot strip gaging in strip-rolling history. In many instances, manual gaging provides only one micrometer measurement to serve as an index of the thickness of 5000 or more square feet of strip.

This measurement is frequently made under such adverse conditions as to arouse doubts as to its accuracy. It is not only a poor index in itself, but the fact that the reading in many cases comes to the roller only after he has rolled several additional slabs further mitigates against its usefulness. With the x-ray gage located immediately after the last pass, an indicator right in front of the roller tells him continuously and almost instantaneously the thickness of the strip coming out of the mill. X-ray gages can be used to definite advantage

Figure 4 — Rejectable seams are indicated by light in handle of seam depth indicator.

Figure 5 — Detector unit of seam depth indicator.



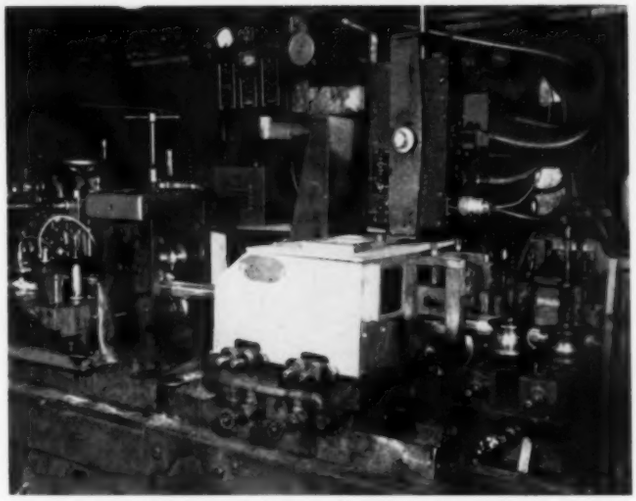


Figure 6 — Equipment shown is used for inert arc welding of tubing.

on cold strip mills also, especially when they are operated at high speed, but the value is not as nearly universal as on hot mills.

Another development of interest primarily to fabricators is a straightness indicating device. Figure 3 shows it being used on tubing. Previous to this electrical development, the operator rotated a tube on ways and depended upon contact with dial gages to show him whether or not the tube was outside of tolerance in regard to either straightness or ovality. However, each operation required him to read each and every gage of the machine. Anywhere from 3 to 8 gages might be used. In the installation illustrated in Figure 3, the use of electrical pressure devices operating within the specified tolerance permits the replacement of the dial micrometers with signal lights which operate only when the piece being inspected is outside the specified limits. This reduces fatigue and errors, and also speeds up the operation.

The next gage was developed entirely in the laboratory and is used to measure the depth of tightly closed seams. It is called the seam depth indicator and is shown in Figures 4 and 5.

For many uses, shallow seams in billets and other steel products are perfectly harmless and acceptable to the customer. If, however, the steelmaker cannot measure seam depth with reliable accuracy, this information is not much good to him. To be safe, he must reject all seams or deface the product by filing. With this instrument, however, he can locate all seams over the maximum depth allowed and reject only those that must be rejected.

In Figure 4 the operator is inspecting billets for rejectable seams. The lower dial of the instrument on the operator's left is adjusted to the depth of seam that can be accepted. If the detector in the operator's right hand is moved over a seam of rejectable depth, a light flashes in the detector handle. Figure 5 is a top view of the detector unit, with the signal light visible at the left end of the handle.

The possibilities of this instrument in automatic detection, marking and segregation are obvious.

WELDING

Welding is another field in which the laboratory organization has been active. Welding is a fast growing, fast changing art, and when many plants have become involved in the use of almost every known method of welding, it is a rather complex job to get to the key men in each plant the pertinent information regarding new methods and techniques. This has been accomplished to a certain degree by setting up welding committees, one in the manufacturing divisions, and another in the steel plants and by making the members the key men through whom information on welding is transmitted to the districts and divisions. The work of these committees is supplemented and reinforced by highly trained technical personnel in the laboratory. In spite of the fine work done by many manufacturers in the welding business, individual operating problems frequently arise that cannot be solved by equipment and knowledge obtainable from the manufacturers. This has led to the construction of new equipment and the development of new techniques. In our case this applies particularly to inert arc welding as illustrated in Figure 6 and submerged arc welding as illustrated in Figure 7.

Figure 7 — Submerged arc method of welding is here used to fabricate open hearth floor beams.

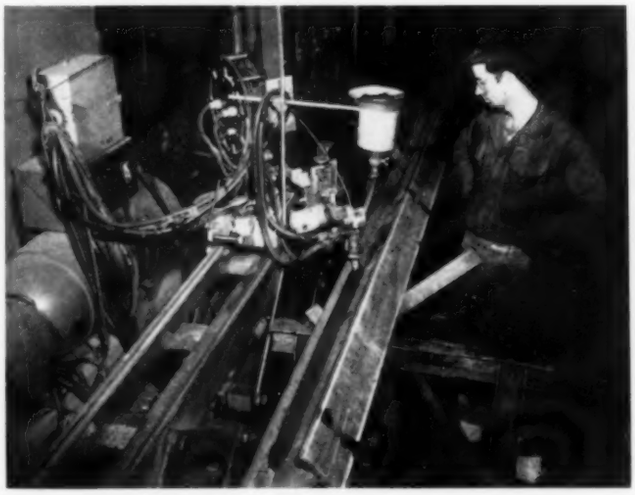


Figure 8 — Roll is being hard surfaced by the submerged arc method.

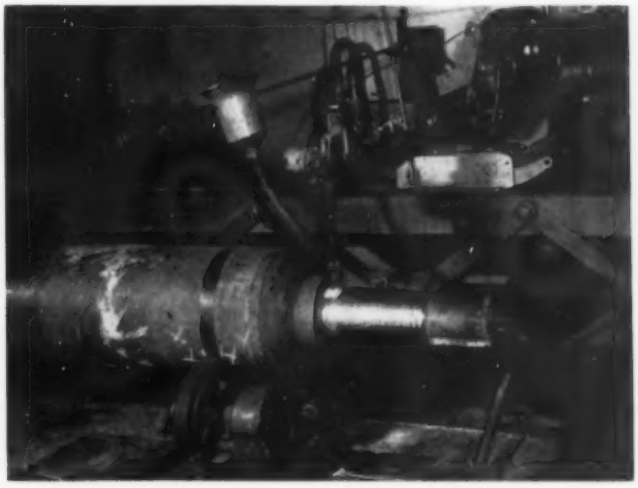


Figure 9 — Miscellaneous induction heating coils show wide variety.

Investigation of any new material or method is normally confined to one plant. The information obtained by local investigations is broadcast to the other plants so that duplication of tests is avoided. This procedure is economical for the user and also for the vendor. Furthermore, the barrage of conflicting claims laid down by welding salesmen is, to put it mildly, confusing and an orderly setup for investigation helps to separate legitimate from unwarranted claims.

One welding operation which has received special attention from the steel plant welding committee is hard surfacing. Figure 8 illustrates hard surfacing of a roll by the submerged arc method. Even though hard surfacing is widely used, its importance, its potential value, its complications and ramifications in the steel industry are not always appreciated. The many aspects of hard surfacing are so complex that as a rule a small organization must depend entirely upon the rod manufacturer for its information. However, when several steel plants are concerned, a careful study and conscientious distribution of information justifies itself by yielding large returns.

It has been found for instance that many users apply an expensive material to all types of applications, even though an alternate material at a fraction of the price would be entirely adequate. Also in spite of the widely known fact that no one material will counteract all types of wear, there is still, strange to say, a strong disinclination on the part of responsible supervisory personnel to give hard surfacing more than one trial. However, steady progress has been made in the more efficient use of hard surfacing and more will be made in the future.

INDUCTION HEATING

Another modern electrical development which has received considerable attention is induction heating. Although the principle is widely known and used and the manufacturers have accumulated an extensive fund of knowledge and experience, it was nevertheless found profitable to go into the subject thoroughly ourselves in order to make the most economical application of the principles to our own particular problems. A group of coils shown in Figure 9 is indicative of the variety of work done. In doing this, we have been surprised at the number of indirect and unexpected benefits that have accumulated in addition to the obvious ones prompting the investigation.

One application that may be of interest is the use of induction heat to anneal the weld of alloy tubing. To produce electric welded tubing, a strip is passed through a forming section which forms the strip into a tube. It is then welded by electric resistance and passed through sizing and straightening rolls to obtain the desired dimensions and straightness. In the case of some alloys, the weld hardens upon cooling so that it cannot be passed through the sizing and straightening rolls without cracking. However, a properly designed induction heating coil located a short distance after the weld, stress-relieves the weld sufficiently so that the tube can be passed through the sizing and finishing rolls without cracking.

Figure 10 — Device is used for sorting steel mixtures.

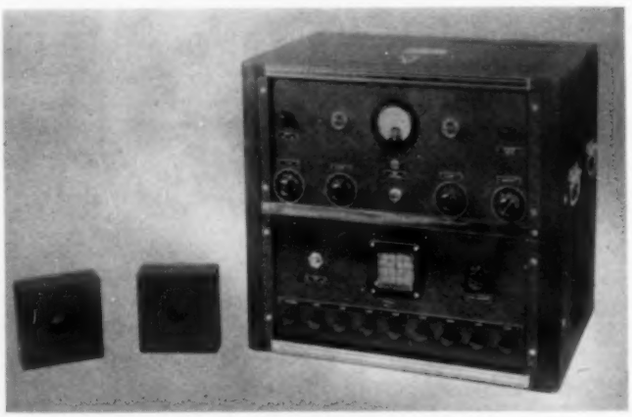


Figure 11 — Another model of a device for sorting steel mixtures.

Another application somewhat outside the steel producer's field, but which may be of interest is drying of painted steel objects by induction. Tests showed that inductive heating of painted pipe dried paint about 10 times as fast as an oven would. This is due to the fact that an oven dries the outside layer first, making it difficult for the inner layers to dry; the inductive heat works in the opposite direction, drying the inside first. When the pipe is heated by induction, the volatile gases escape easily throughout the entire drying process.

SORTING OF STEEL MIXTURES

Another problem to which considerable attention has been given is sorting of steel mixtures by magnetic and

other means. Several years ago when the investigation was started, there were in addition to the commonly known devices, such as spark testing, sulfur prints, etc., certain commercially available instruments that could be used to make some separations. They were so limited in scope, however, that they were no solution to many of the problems encountered. One such problem was to monitor low alloy tubing and bars so that no plain carbon steel product would get through the production line and mixed in with alloy about to be

Figure 12 — This instrument sorts mixed metals by thermoelectric effects.

shipped. For this purpose a circuit was developed and installed on the stencilling machine, the final operation before shipping. The sorting circuit would automatically stop the entire machine whenever a piece of low carbon tube came along. The operator would then throw it out, reset the circuit and proceed with production. From this development emanated the construction in the laboratory of small portable units which are used widely throughout the corporation. One of these is illustrated in Figure 10. Since then instrument manufacturers have improved their products and can do a much better job of separation than was being done when the instrument in the illustration was first built. The instrument in Figure 11 is an example.

Another instrument called the identometer is of interest although its usefulness is limited. It is illustrated in Figure 12. In the use of this device a minute spot weld is produced between the piece to be tested and a

Figure 13 — Reflectoscope detects internal defects by ultrasonic vibration.

piece of known analysis, thereby creating a hot junction. An electromotive force generated between that hot junction and a cold junction indicates that the two pieces differ. If they are the same, no electromotive force is generated. This sounds like and is a rather awkward method for use in separating mixtures, but it has been found satisfactory in instances where no other method would work. One good example was a mixture of two similar analyses of stainless steel. The material had been returned from the customer in pieces that had been cut to exact length. Samples for chemical analysis could not be cut without making the pieces too short and consequently scrap from the customer's point of view. None of the common quick methods worked. However, a few chemical checks revealed that the Identometer could make a reliable separation. The tiny spot weld was almost imperceptible and a large quantity of stainless tubing was salvaged by this method.

NON-DESTRUCTIVE DETECTION OF DEFECTS

Considerable attention has also been given to non-destructive detection of defects. This includes many methods: ultrasonic, magnetic, resistance, inductive, magnetic powder and others. Such tests are applied to

Figure 14 — In the reflectoscope, the ultrasonic wave is reflected from the defect.

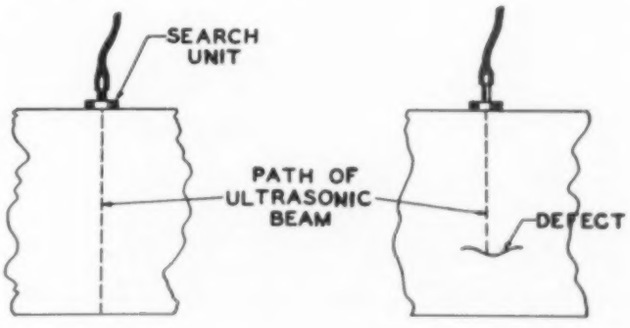


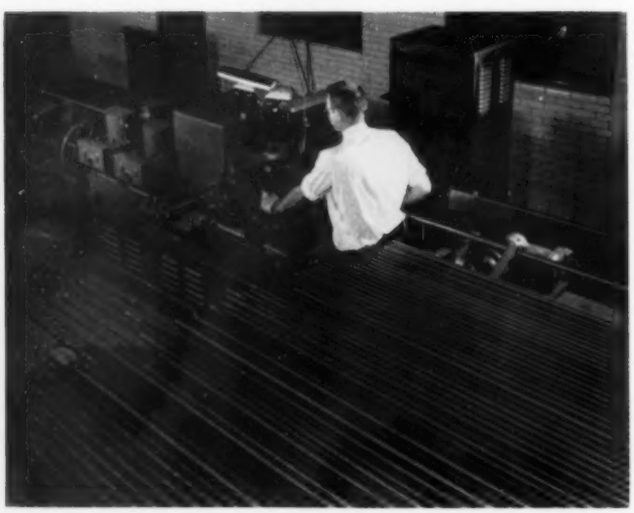
Figure 15 — The reflectoscope is used in preventive maintenance to detect internal defects.

ingots, blooms, billets, bars, pipe and other products. Two of these have been given special attention:

1. Ultrasonic inspection for internal defects.
2. Detection of defects in cylindrical parts by induction of circumferential currents.

The reflectoscope was put on the market in 1944. It was the first commercial instrument using ultrasonic methods for the detection of defects. Our original application, in January 1945, was the detection of internal defects in billets as illustrated in Figure 13. By making contact with the surface of the billet through a film of glycerine or similar liquid, a mechanical pulse of a frequency higher than that of audible sound is transmitted into and through the steel. If the steel is sound, the pulse reaches and is reflected from the opposite side. If the steel is defective, the pulse travels only to the defect and is reflected from it. This principle is illustrated in Figure 14. The same device that transmits the pulse also receives and measures the echo. The time between transmission and echo is a measure of the distance the wave traveled.

Figure 16 — Defects in tubing are being found through the use of induced circumferential currents.



The term commonly used to designate this method used to be "supersonic." That word was, however, at the same time being used with increasing frequency to designate speeds above the speed of sound. To avoid confusion, "ultrasonic" is the term now used to describe testing by frequencies above the audible range, i.e. above 20,000 cycles per second. The reflectoscope method of defect detection is therefore called "ultrasonic testing."

While this instrument was originally used for production inspection of billets and blooms, it also has important usefulness in maintenance work. For instance, if the crystal is placed on the end of a shaft, and the beam transmitted along the axis of the shaft, a defect can be shown up anywhere along the length of the shaft. In Figure 15 the man at the lower right is holding the crystal in place.

To provide service in the districts not equipped with reflectoscopes, the electrical laboratory maintains a truck and takes the instruments where needed. In districts with 25-cycle power, a small alternator converts to 60 cycles for operation of the instrument.

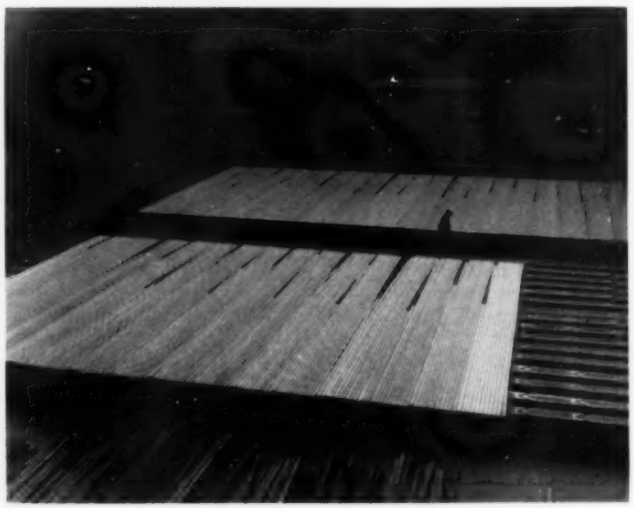


Figure 17 — Automatic length control. Rejectable shorts are eliminated by making two usable shorts instead of one full length and one rejectable short.

At times the defects detected are considered too small to be harmful. If repeated examinations show no growth, nothing is done about the defective condition. If, however, repeated examinations reveal that the defect is growing in service, the part is replaced when the defect becomes objectionably large. The savings to be derived from such a practice are self-evident.

As mentioned above, another testing method is the use of induced currents in circular parts. It is used on tubing, pipe and bars. The equipment is pictured in Figure 16. Circumferential currents induced in the part are the basic feature of this method and in its application, the department has gone through the entire gamut of development work from early and elementary experimentation to construction, installation, and maintenance of production machines. By the use of this method, defects $\frac{1}{16}$-in. long and halfway through the tube wall are detected at a speed of 80 fpm. The mere detec-

tion of defects is in itself not a notable accomplishment. With the extremely high amplifications available in electrical equipment today, the mere detection of small defects in cylindrical steel parts is relatively easy. The difficult problem — the problem which caused headaches during many years — is differentiation of the effect of those small defects from the numerous harmless variables that occur in steel and which produce almost the same electrical effect. This is the important test to be applied to all so-called sensitive non-destructive testing methods. The sensitivity to small defects is relatively easy to attain in most cases. The differentiation of those small defects from the numerous other variables that occur, however, may be extremely difficult and is many times impossible. It required a long period of development and close coordination of laboratory and mill effort to bring the equipment to the degree of reliability required for economical operation by non-technical personnel.

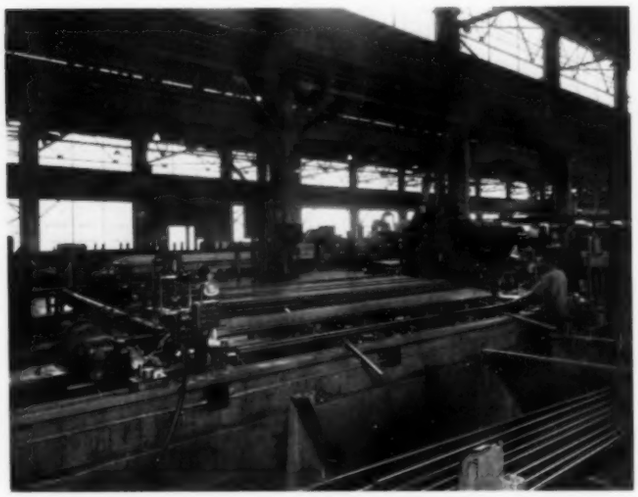


Figure 18 — Automatic controls for hydrostatic testing of pipe.

AUTOMATIC CONTROLS

Some developments which have been especially interesting are special automatic controls for reducing labor and increasing yield. In spite of the many elaborate automatic controls used on steel mill equipment, this still remains a rich field for development work. However, it requires technically trained men with ingenuity who are willing to stick close enough to the job to make careful analysis of what the job requires and to follow it up so as to be sure that their solution takes care of all exigencies.

One interesting application was on a billet mill where a considerable tonnage of billets was scrapped because of a certain minimum length requirement. By installing a specially developed control for the shear and using photoelectric cells suitably located on the mill, all billets are cut to a usable length and rejectable shorts are thereby eliminated. The results are illustrated in Figure 17. Life of photoelectric cells on this installation has been especially interesting. In this location they are subject to extreme mechanical and thermal shock, but in spite of the adverse conditions, photo cells removed for examination after 2½ years' service were still in good operating condition. This contradicts the common impression that electronic tubes are too fragile to be used extensively for mill controls.

Another interesting development was improved control devices for the testing of pipe by hydrostatic pressure. In this instance, illustrated in Figure 18, timing, magnitude of pressure, and handling are all automatic and one man takes care of the entire operation, including inspection.

Another example is in the operation of the flash welding machine pictured in Figure 19 in which the operation has to be completed in an extremely short time. The job had become so difficult and so exhausting that it was almost impossible to keep a man on the job. Added automatic features and consolidation of controls in one location simplified the job enough so that this difficulty was eliminated. Incidentally, weld quality was definitely improved.

Figure 19 — Automatic controls on a flash welder make work easier and improve weld quality.

As indicated above, such applications are numerous but they require close cooperation between the technical and the operating personnel in order to arrive at a satisfactory solution.

RESISTANCE STRAIN GAGES

Another group of developments which has required the entire gamut of service from investigation of new instruments through consultation, development, construction, etc., into maintenance is the use of resistance type strain gages. An SR-4 resistance strain gage is simply a fine wire firmly cemented to the object in which the strain is to be measured. Changes in strain in the object change the resistance of the gage which is connected in a bridge circuit for detection of the resistance changes.

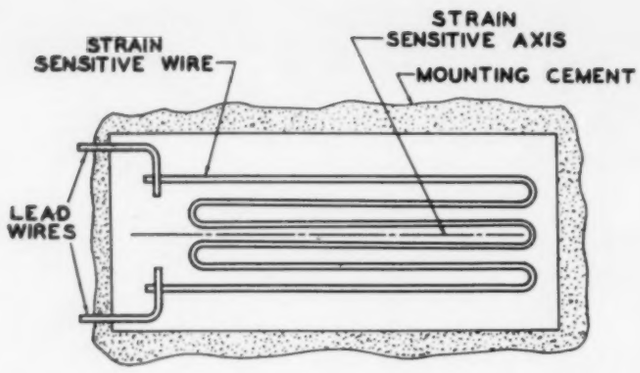


Figure 20 — In SR-4 strain gage, strain is measured by resistance change in a fine grid glued to the part in which strain is to be measured.

The simplicity of this type of gage is apparent in the diagram in Figure 20. A fine wire grid is glued to paper which is in turn glued to the stressed part. When a load is applied, the wire stretches or compresses with the part and unbalances the bridge circuit. The amount of unbalance is a measure of the load. Hundreds of thousands of these things have been used in airplane design and development. As higher sensitivities and complicated records are required, the instrumentation becomes more complicated. Figures 21, 22 and 23 illustrate some of the instruments that have been used in this work.

These devices have been used in our organization to measure pressures on parts being welded by electric resistance, stress distribution in a monorail system, pipe line instantaneous pressures, loading on various presses to determine safety factors and analyze causes of machine failures, forces on drawbenches for cold-drawing and for many other purposes. One of the more interesting applications was a study of loading on open

Figure 21 — Elementary instrument used in conjunction with the strain gage of Figure 20 is essentially a bridge circuit.

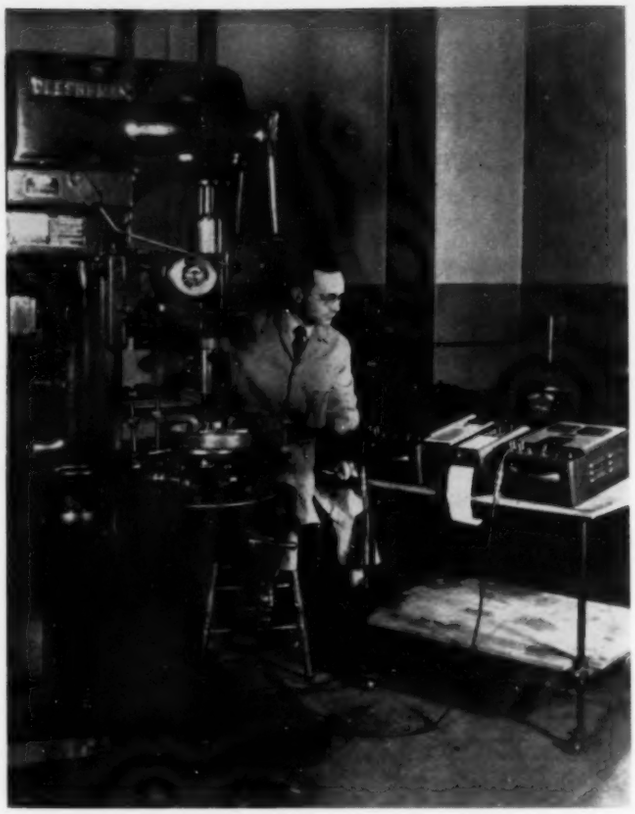


Figure 22 — Other additional instruments may be used with the strain gage of Figure 20.

Figure 23 — Recorders can be set up for simultaneous recording of strain at several different locations.

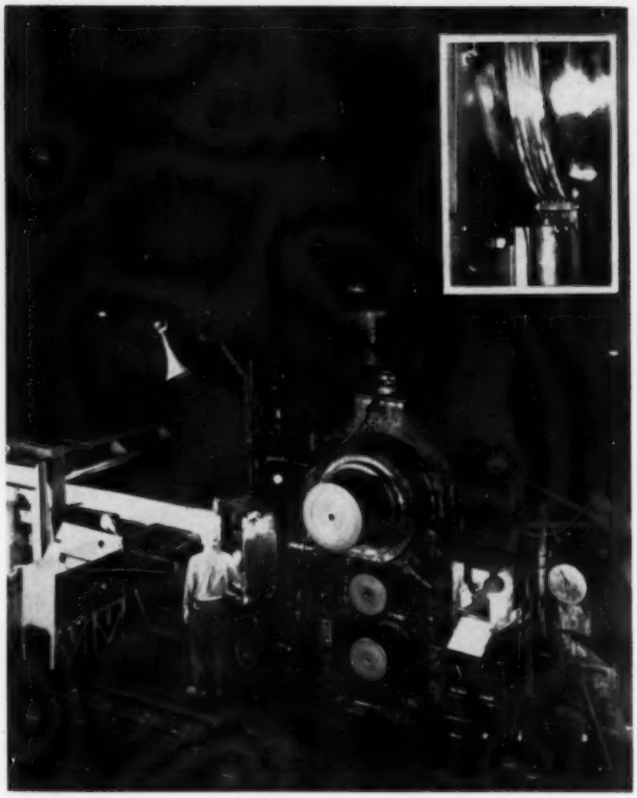


Figure 24 — Slip rings shown in inset were used in conjunction with strain gages to measure torque in large shaft near center of picture.

hearth crane girders. In attempting to increase the capacity of an open hearth shop, the engineer had anticipated many expensive alterations in the crane girders.

Figure 25 — Strain gage crane scale shown has a 50,000-lb capacity.

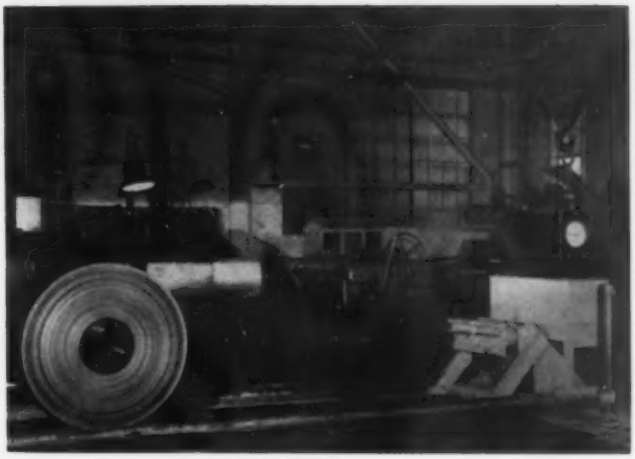


Figure 26 — Strain gage platform scale shown has a 30,000-lb capacity.

A strain gage study showed him that some of these changes were entirely unnecessary and he thereby saved many thousands of dollars in expensive alterations and lost production. Another engineer, on the other hand, had torque measurements made on the broadside pass of a hot strip mill. Using the slip rings illustrated in Figure 24 and the instruments of Figure 23, he found that the actual torque was far above his calculated torque. This test indicated the inadequacy of his design and thereby saved him from wasting many thousands of dollars on inadequate equipment. This device has even been used in determining the modulus of elasticity in brick.

While the above instances indicate the wide variety of potential applications, of the resistance type strain gage, it seems probable that it will ultimately come into its most general and most extensive use in weighing applications. One example is the 50,000-lb scale used for crane weighing illustrated in Figure 25. Another example is the platform scale of Figure 26, which has been used to weigh coils in motion for 2½ years. As the coils leave the mill, they roll down the platform and, when leaving the platform, actuate a switch which locks the indicator in position. The weighmaster then reads the weight and resets the instrument to zero by the pushbutton.

One scale manufacturer has now entered the field of strain gage weighing and is offering this type of scale. Other manufacturers offer components designed especially for weighing. The advantages are great enough to indicate a large future market.

This article merely hits the high spots to give some idea of the ramifications of the work of an electrical laboratory on special projects for a steel corporation. The economies to be derived from work of this kind have just barely been touched, and the rapidly increasing cost of operation makes it imperative that more and more of them be explored.

Steel producers, like other manufacturers, are becoming more and more aware of the importance of knowing their product thoroughly. They see the need of developing the best possible means of determining the soundness and other characteristics of their product even before the customers' requirements make it essential.

An electrical laboratory, cooperating closely with all other branches of engineering and integrating its activities into production needs, provides an excellent avenue by which these objectives can be achieved.

DISCUSSION

PRESENTED BY

ANDREW D. MUIR, Plant Metallurgist, Page-Hersey Tubes, Ltd., Welland, Ontario, Canada.

R. D. HINDSON, Metallurgical Supervisor, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

W. A. BLACK, Engineer, Steel and Tubes Div., Republic Steel Corp., Cleveland, Ohio.

JOSEPH L. WALTON, Superintendent No. 1 Open Hearth, Bethlehem Steel Co., Lackawanna, N. Y.

F. J. FARQUHAR, Assistant Superintendent, Page-Hersey Tubes, Ltd., Welland, Ontario, Canada.

AUGUST F. MOHRI, Chief Metallurgist, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

JOHN GERRARD, Assistant Superintendent, Hot Strip Mill, Bethlehem Steel Co., Lackawanna, N. Y.

R. W. GRAHAM, Superintendent Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

Andrew D. Muir: I have been very interested to hear the comments on the detection of seams or other harmful defects, particularly as applied to pipes and tubes. I would like some comments on the best method of detecting harmful segregation bordering the rim zone of rimmed steel used for electric resistance welding.

W. A. Black: I do not have a solution to that problem. The best method available is probably the ultrasonic testing, but you must have an actual discontinuity or non-metallic inclusion for it to be detected. The definition of "harmful segregations" is rather tricky. What is harmful in one case is harmless in another, and it would be difficult to give a general answer that would meet all conditions. About all I can say to that is that ultrasonic testing is the best answer to the problem, but whether it would meet the particular one you have in mind, I cannot say.

R. D. Hindson: In your applications you stress the use of ultrasonic testing in maintenance problems, and also showed its use on billets. I am wondering if you would enlarge a little more on the actual application of ultrasonic testing on your steel products. Are you using it to determine the proper yields that you should obtain from your products?

W. A. Black: I cannot say that it is used exactly that way. All I can say is that it is used for inspection purposes to determine the amount of rejectable material, and where to cut the billet or slab. Instead of cutting off samples and examining them in the laboratory by etching, which is an expensive and slow laboratory process, the mill inspectors find out by ultrasonic test just how far the rejectable condition extends and cut it at that point. Insofar as that predetermines the yield, they do what you ask about.

It is definitely a production test. Its use depends on the type of product in the individual mills. In some mills it is used constantly. In others it is a sporadic test but it's most important use has been a continuous test of certain types of products. I would have to refer to the metallurgists to find out just what the products are.

R. D. Hindson: How about preparation of surfaces before testing?

W. A. Black: That depends on the experience of the operator. When we first started using that method of testing, preparation of the surfaces received a lot of attention and required a lot of time, and that is true in any case in the initial use of the instrument. As you become more familiar with the reaction and get accustomed to certain surface conditions you can interpret what you see on the instrument more readily. You can then tolerate poorer and poorer surface condition. Whereas, originally, the operators in the plants that have been using this instrument the longest time, used a grinding wheel all the time, they now use it just rarely.

R. D. Hindson: Can he test right through the scale?

W. A. Black: Yes. You must normally have the surface smooth enough so that you get approximately 60 per cent contact with the crystal, but you can sometimes get away with even less than that. The degree of adverse conditions that can be tolerated really depends on the skill and experience of the operator.

Joseph L. Walton: You referred to testing shafts and gears with this instrument. Do you test shafts of open hearth cranes which handle hot metal?

W. A. Black: Yes.

Joseph L. Walton: Is that standard practice?

W. A. Black: A lot depends on the district. I might say that in the districts where maintenance personnel are most alert, it is done regularly.

F. J. Farquhar: Could ultrasonic testing be used for determining whether a weld is sound in a butt-welded pipe?

W. A. Black: Yes, it can, if there is actual discontinuity. If you have metallic continuity and the weld happens to be brittle, ultrasonic testing is of no value in detecting the brittleness. If you are trying merely to differentiate between a weak weld and a strong weld, you cannot use ultrasonic testing, but ultrasonic testing would detect actual discontinuity or lack of weld. However, I do not recommend it for tubing. It is too awkward to use.

August F. Mohri: I was very interested in the illustration you had showing the weighing of billets by crane and a measuring device or portable carriage of some kind. Could that same device be installed in the crane cab so that the craneman would act as a craneman and weighman, or is it so cumbersome that it has to stay on the ground level?

W. A. Black: Yes, it can be installed in the crane cab. Several companies have developed equipment for this purpose.

Andrew D. Muir: How do you compensate for temperature fluctuations in weighing?

W. A. Black: That is compensated for in the construction of the cells. One column with strain gages mounted on it does not carry any of the load but serves the purpose of automatically compensating for temperature effects. Extremes of temperature, however, re-

quire special attention. Temperature variation is a serious problem in connection with the use of strain gages for weighing.

Jack Gerrard: If you have a backup roll with a 79-in. body, a 49-in. diameter, a 30-in. neck, a 4-in. core, and a work roll of 25½ in. diam and an 18-in. neck, will the ultrasonic machine detect fractures in the rolls?

W. A. Black: I would expect the ultrasonic tester to be effective in detecting defects of that type. Is this cast rolled or forged?

Jack Gerrard: Cast.

W. A. Black: Transmission through casting is generally poor, so you might run into difficulty. It may test, and may not. Some materials do not transmit the signal at all. If it is porous, the signal may not go through it. Sometimes selection of the proper frequency helps. A low frequency of, for example, 1 megacycle sometimes goes through material that a frequency of 2½ megacycles will not go through.

R. W. Graham: You mentioned an x-ray machine. I wonder if you could tell us about what per cent of availability the x-ray machines give on measuring strip.

W. A. Black: Do you refer to the percentage of outage?

R. W. Graham: That is right.

W. A. Black: I am not acquainted with actual production figures, so I cannot give you much information on that. I do know, if the production men were having any serious trouble with it, they would be asking for help. In the absence of such requests, I gather they have not had unreasonable trouble with it.

R. W. Graham: I would like to ask if you have had any experience with the back scatter-ray machine, which I understand is coming on the market.

W. A. Black: I have had experience with the beta-ray gage. It has a limited field in the line of gaging. However, I do not see any reason why it should not work satisfactorily in its field, and be built for a fraction of the cost of the x-ray gages. As a matter of fact, we had what was probably the earliest model built. It was entirely unsatisfactory but I have seen improved models that are in constant production use so it is apparent that it does have possibilities.

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By R. J. SIMES
Assistant Superintendent
Mechanical Maintenance
Lukens Steel Co.
Coatesville, Pa.

. . . . by making the controls easier to operate, it has been possible to increase the efficiency of the mill . . . .

▲ THE controls described in this paper are those on the Luken's 140-in. hot plate mill, and have been in successful operation for the past year. This mill was originally installed and put into operation about 1900. During the ensuing years many changes have taken place, and many improvements have been added. Some of the more recent major improvements include:

1. Replacing the cast iron main mill housings with cast steel housings.
2. Replacement of the front and back tilting tables with tilting tables of a new and improved design. This improvement necessitated replacement of almost the entire foundation for the mill and front and back tables. Into this was incorporated a new and greatly improved scale removal system.
3. The original steam engine drive for this mill has been replaced with a modern electric motor drive, which is housed in a motor room equipped with all the necessary facilities for efficient operation.
4. The oil and grease cups and manual application of lubricants have been replaced with automatic oil and grease lubrication systems. In short, a great deal of effort and many dollars of investment have been expended in applying new developments and improved equipment to this unit.

The mill proper as previously indicated is a three-high mill consisting of a top and bottom roll, with a 140-in. long rolling surface and 38 in. in diam, and a middle roll, 140 in. long by 22 in. in diam. The top roll is carried by two journal boxes or chucks, one at either end, which contain the bronze bearings in which the roll rotates. These chucks are retained in the housings and are guided by the housings in their vertical travel. The top roll and chucks are supported in position by two constant pressure hydraulic cylinders; one located under each housing. These cylinders keep the top roll chucks in contact against the screw points of the screwdown mechanism. This enables the operator to adjust the mill to the proper opening as the rolling of a plate progresses. The middle roll is similarly carried in the housings and is also supported by two hydraulic cylinders; one located under each housing. However, the pressure to these cylinders must be controlled so that it can be turned on or off as the rolling progresses. It is the control of the pressure on these cylinders which will be described more fully later in the paper. The bottom roll is likewise supported in chucks, but remains in one fixed position in the housings.

The mill is driven by a recently installed electric motor drive. The motor is a 4000-hp, constant speed, non-reversing motor which is directly connected to a large speed reducing gear set. This in turn, through a lead spindle, drives a pinion set where the speed is further reduced and the transmission of power divided and carried to the mill by two other spindles. One of these goes to the top roll and is called the vibrating spindle. The one end of this spindle is attached to the top pinion, the other end to the mill. The pinion end remains at the same elevation, while the mill end moves up and down vertically with the top roll to suit the required opening of the mill. The other spindle known as the bottom spindle connects the bottom pinion and the bottom roll. It remains constantly in a horizontal position while driving the bottom roll. The middle roll, which is not driven, rotates entirely due to the friction created by its bearing against either the top or bottom roll. This, of course, is accentuated when material is passing through the mill.

The mill is supported by an ingot receiving, or approach table, and the front and back tables which are immediately in front of, and in back of the mill. These tables are an integral part of the rolling operation of the mill. The material then travels over a runout or leveller approach table, through the levellers to the cooling and layout section, on to the shearing and gas cutting section, and finally to the inspection and shipping sections of the mill.

The primary characteristic of a three-high mill is the

non-reversing drive. This necessitates the floating, or moving middle roll, and the tilting front and back tables. To further explain, in order to roll a plate on this type of mill in continuous consecutive passes it is necessary to make the pass in one direction at one level, and the next pass at a different level coming from the other direction. In other words, one pass is made between the top roll and the middle roll, while the next pass is made between the bottom roll and the middle roll. The reduction for each pass of the plate through the mill is predetermined to suit the size and type of material. This is accomplished with the screwdown mechanism that moves the top roll down, thereby, limiting the vertical travel of the middle roll. This ultimately enables the operator to produce a finished plate of the desired size and gage.

The front and back tables, as previously mentioned, are an integral part of this type of mill. They not only convey the material to and from the mill, but also are capable of delivering and receiving the material at the proper elevation to suit the middle roll and direction of the pass. The front and back tables are actually two separate units, consisting of two side girders that are held together at various points in their length by spreaders. These support the table rollers, line shafting, etc. The table rollers are electrically driven by two separate drives; one on either side of each table. These are reversing drives to enable every roller to be driven in the same direction, or every other roller to be driven in opposite directions at the same time. With certain of these rollers being tapered, the operator is enabled to turn the ingot on the table. This facilitates side or end rolling as desired. At a point near the back of each table, at an equal distance from the center line of the mill, there is located a fixed pivot point about which the tables move in their up and down, or as we refer to it, tilting motion. This motion is accomplished by what is known as the tilting mechanism which consists of a hydraulic cylinder that supplies the power for the motion. This power is transmitted through a series of bell cranks, connecting arms, pivot points, and counterweights. The one cylinder provides the power for both tables. The linkage ties these tables together to make sure they operate in unison. It is the controls for this cylinder, as well as the previously mentioned middle roll cylinder, that will be described more fully.

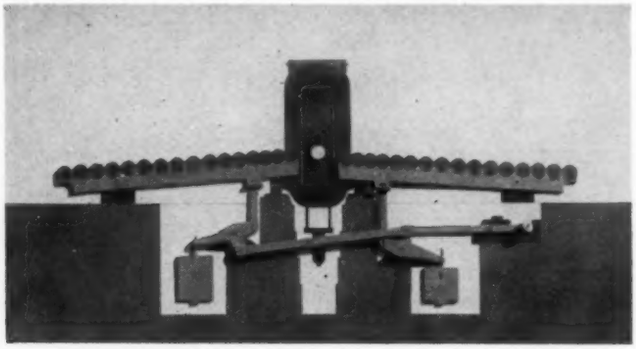

Figure 1 — Model shows 140-in., 3-high mill and tilting tables at the Lukens Steel Co.

First, let us go back a bit and outline the original method of controlling these cylinders and mention some of the problems which we have overcome with our new method. The middle roll and front and back table tilting mechanism cylinders were previously hydraulically operated and manually controlled. This was accomplished as follows: the necessary hydraulic water pressure is supplied by our central hydraulic system at 550 psi, and conveyed through the necessary piping, control valves, etc., to the cylinders. The middle roll control valve previously used was of the sliding piston, or spindle type, commonly referred to as a "jack." This valve was mounted horizontally and was hand operated by a lever which protruded above the main piston and cylinder body of the "jack." The lever pivoted at its lower end and was attached to the piston with a yoke. A forward or backward stroke of the lever moved the piston in the cylinders or valve body, permitting the passage of water through the desired ports to obtain pressure to cylinders, or cylinders to exhaust, as desired. The holding position was obtainable by centering or moving the lever to a vertical position which closed all ports. This held the pressure on or off the cylinders as desired.

The front and back table tilting mechanism cylinder control valve previously used was similar in construction and operation to the middle roll "jack," except that it acted as a pilot valve to the actual operating valve which was mounted remotely from the control "jack" or in a position near the operating cylinder. The function of this "jack" was to control the high pressure water to the operating valve. This in turn caused the pistons in the valve to operate and control the flow of water to the tilting mechanism cylinder, or from the cylinder to exhaust as required.

For reasons of efficiency of operation, as well as economy, we have found that the most practical operation of this mill requires that one operator must control the direction of rotation of the front and back table rollers, the positioning of the middle roll, as well as the tilting mechanism. He has other controls which he must operate that need not be dwelled upon, except to mention that for convenience of operation, these controls were all grouped together in a pulpit provided for the comfort and protection of the operator. Due to the nature of this work, and the constant concentration required, etc., it has been found necessary to provide a chair for the operator to sit on. This of course necessitated mounting the necessary controls within easy reach of the operator. This resulted in all of the controls being grouped very close together. The necessity of close grouping of electrical and hydraulic controls that had previously existed in our operating pulpit was one of the chief reasons for the eventual discarding of the old system and installation of the new. This type of "jack" used in comparatively high pressure systems presents almost an endless maintenance problem in trying to keep it perfectly dry and free from leaks, both in the "jack" and the piping adjacent to the "jack." The almost continual operation of the valve, plus the surge created by the quick opening and closing, caused the area around these "jacks" to be wet or damp most all of the time. This resulted in frequent electrical trouble with the adjacent electrical control equipment. The wet floor surrounding this area created an unsafe and unhealthful work area, to say nothing of the damage caused to the steel structure of the pulpit by

the water and dampness. In addition to the preceding, the actual operation of the "jacks" contributed somewhat to the decision of improving these controls. In an average 8-hour operating turn on this mill when rolling finished plates, approximately 96 plates are rolled with an average of 25 passes per plate. This results in 2400 strokes of each of the two "jacks" or 4800 strokes. These "jacks" require from 5 to 10 lb force to move the handle from one position to another. You can readily see this required quite an expenditure of energy on the part of the operator, causing a tendency toward fatigue and less efficiency toward the end of his 8-hour turn at the controls.

With our new hydro-electric controls, or perhaps a more descriptive phrase would be "hydraulically operated — electrically controlled mill and tables," we have overcome completely the leaky valve and pipe situation in the operating pulpit. This has resulted in a much neater, cleaner, safer, and more healthful work area. We feel we have very greatly reduced the effort and energy required of the operator, as well as reducing the maintenance required. All these factors have resulted in more efficient operation of this mill. This was accomplished by the purchase and installation of a new control system. This equipment had been developed and made available to industry some years ago by a well known hydraulic equipment manufacturer. It remained only to make the proper application of this equipment to this type of service. This was a comparatively simple development that required the assembly of five, already existing, electric and mechanical functions or mechanisms into one efficient control unit. This control unit might be briefly described as an electrically controlled, solenoid operated, air actuated hydraulic control valve. One of the main features of this control unit (this is the one that enabled us to improve on the undesirable conditions mentioned before) is the fact that some of the various components of this unit can be mounted or installed remotely from each other.

This control unit, to describe it more fully, is comprised of the following five components:

1. The electric controller which has supplanted the "jacks" in the operator's pulpit, and has resulted in clearing up all of the undesirable conditions that existed prior to its installation, is of the heavy duty, mill type, totally enclosed, lever operated master controller. The case is readily removable for quick access when maintenance or repair work is required. It is equipped with renewable contacts and the lever is of the multiplying linkage, spring helped, short throw type, and requires only about 8 to 14 ounces to move it from one position to another. This is a decided improvement in the energy required of the operator. This controller has only three positions: first, the forward position which actuates the middle roll or tables in one direction; second, the center or neutral position which holds the middle roll or tables in a fixed position; and the third, is the rear or back position of the controller that causes motion opposite to that of the forward position. There are, of course, two controllers involved in this operation that have replaced the original "jacks." One controller for the front and back table tilting mechanism, and one for the middle roll system. These controllers are mounted side by side at the most convenient height and location to suit the operator when in sitting position so that a minimum of effort and energy is required on his part. To further this aim, the controllers are right and left or opposite hand to each other so that the handles are as close as possible to each other. This permits both controllers to be operated with one hand. The system is also arranged so that the movement of both controller handles in the same direction at the same time provides the desired movement of the middle roll and front and back tables for the normal rolling operation of the mill. However, either controller can be operated individually to meet any required motion.

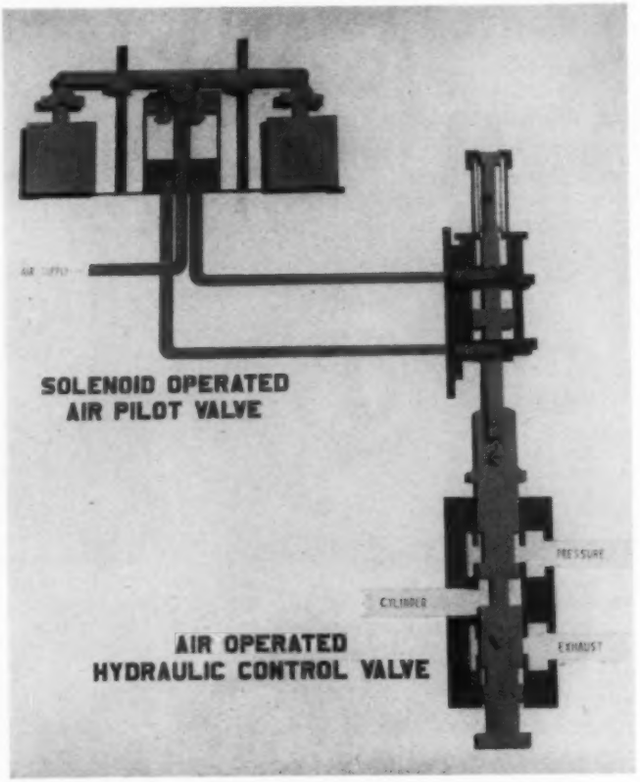

Figure 2 — The model shown illustrates the operation of the electrically controlled, air operated, hydraulic control valve described in this paper.

2. & 3. The second and third components comprising this control are combined as one unit. These are the electric solenoids and the air pilot valve. This is a comparatively small compact unit that can be, and in our installation is, mounted remotely from the electric controller. The only connection required between the controllers and the solenoids is the necessary wiring. This provides for great flexibility of location of these components. The solenoids and the air pilot valves can also be located remotely from the air operated hydraulic control valve. The only connection required between these components is the necessary piping to convey the air from the air pilot valve to the air cylinder on the air operated control valve. However, in our installation we have mounted the solenoid air-pilot valve fairly close to the air operated control valve.

Consequently, only a very short run of pipe was required, and has resulted in a rather insignificant time lag between the various steps in the sequence of operation. This is a rather important consideration that will be later discussed in more detail. We have mounted the solenoid air pilot valve in a protective steel locker equipped with hinged doors to facilitate easy access for maintenance and repairs. This provides a dry, clean, and reasonably dust free installation that tends to give more trouble free service. The solenoid air pilot valve consists of two components. First, the air valve itself is a small sliding piston type valve with the pistons mounted vertically at an equal distance on either side of the vertical center of the valve. Across the top of the valve there is mounted a lever which extends an equal distance to either side, and pivots on the center of the valve. The ends of this lever are connected to the second component. This unit is the electric solenoid. There are two of these located on either side of the air valve. When the right hand solenoid is energized by working the electric controller, a downward motion of the right hand end of the lever takes place, which in turn pushes down the right hand piston in the air pilot valve and permits a passage of air that is transmitted through pipe to one side of the air cylinder on the main hydraulic control valve, through the right hand port of the valve. When the right hand solenoid is de-energized, the lever is spring returned to its neutral position, and the right hand piston in the air pilot valve is spring closed. The solenoid is de-energized by returning the electric controller to the center, or neutral position. Moving the controller to the opposite position energizes the left hand solenoid, and causes the same cycle of motion on the left side of the air pilot valve. By this means, the desired selectivity of motion is executed.

4. & 5. The fourth, fifth and final components comprising this control are the hydraulic control valve and the air cylinder which provide the power necessary to move the control valve. The valve itself is very similar in design to the original hand operated "jack," having a piston, or spindle, directly connected to an air cylinder which is double acting, or capable of being operated in either direction, depending upon which end of the cylinder the pressure is applied. This is controlled by the solenoid air pilot valve, and the electric controllers previously described. When the air pressure is relieved on either end of the air cylinder, the piston in the cylinder is spring returned to neutral, causing the piston in the hydraulic valve to center. This is exactly the same action we previously acquired, and have already described, with the hand operated "jacks." In short we have taken the two original hand operated "jacks" out of the operator's pulpit, replaced them with electric controllers, and have mounted the "jacks" and necessary additional components remotely from the pulpit. The "jacks," or as they now are, air operated hydraulic control valves, perform exactly the same function they did before. The one controlling the movement of the middle roll, the other the front and back tilting tables. This is done in the same manner and sequence of operation we have previously described.

Maintenance-wise we have experienced very little trouble with these two control systems. The mill operates almost continually, eighteen or nineteen turns weekly. The delays due to failure in these controls have been practically zero. The electric controllers require almost no attention, except to occasionally lubricate or replace the contact points. The solenoid air pilot valves have required little or no attention at all. The air operated hydraulic valves, however, require a weekly checking over, and the leathers in the air cylinder require infrequent replacement. The hydraulic valve itself requires replacement of leathers, bushings, etc., weekly. One feature of this installation is the manner in which this valve is mounted. It is so arranged that the piston can be disconnected from the air cylinder and removed from the body of the valve without disturbing any of the other components. The result is that the piston can be removed, new leathers, etc., can be installed and replaced in the valve body, and be back in operation in a few minutes time. All parts are readily replaceable, being manufactured under strict control, so that little or no hand fitting is required in the field.

As previously mentioned, one very important item in the design of this type of control is the speed at which it is desirable to have it operate the mill, table, or whatever type of equipment it may be installed. On the installation here described it was first necessary to arrive at the most efficient time required for the motions involved. This, having been established, there were certain other existing factors to consider which were the pressure and volume of water available for the job, the diameter and stroke of the cylinders concerned. All these factors having been determined, it was then necessary to select a control valve of the proper size to pass this predetermined amount of water in the time previously established as being the most efficient operating time for the unit involved. This particular application presented somewhat of a problem in this respect; due to the very close coordination required in these two separately controlled mechanisms, the two hydraulic valves had to be of the proper size and independent of one another, so that when the operator moved his controller in the pulpit, both the middle roll and front and back tilting tables reached the end of their movement at the same time. This was accomplished by the selection of the proper size of valves. However, should the travel of one unit have been faster than the other, it could probably have been remedied by the addition of a throttling valve in the line between the operating valve and the cylinder of the faster of the two. However, this would only be a means to an end, and does not make the most desirable application of this system of controls.

In summary, this system has been in successful operation for the past year. Also during the past year, we have installed quite a number of additional control systems of this type on other equipment in our plant. It is now being used on shears, flattening, punching, and forming presses, furnace doors, mill table pushers, etc. In all cases we have experienced very successful and gratifying results.

DISCUSSION

PRESENTED BY

F. L. WISE, Assistant Superintendent of Maintenance, Saucon Division, Bethlehem Steel Co., Bethlehem, Pa.

H. H. ANGEL, Electrical Engineer, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

R. J. SIMES, Assistant Superintendent, Mechanical Maintenance, Lukens Steel Co., Coatesville, Pa.

F. L. Wise: I would like to ask why the three mediums, when I believe the same thing could be accomplished with just two. As I understand it, you go from the electric, to the air, to the hydraulic.

We have some similar installations in which we eliminate one of these steps. You did mention the ease with which you can connect this up — that you merely have to run your electrical leads from your pulpit down to your solenoids. Was that the only reason, or is there some other reason for using the three mediums?

H. H. Angel: In cold strip and hot strip mills there is often a question whether to use a valve hand, operated, or solenoid operated. I have seen installations where in one case you may have some hand operated valves mixed in with some electric master switches, and in other cases you would rather have all master switches instead of master switches and levers. Therefore, the extra complication of using a solenoid in connection with the pneumatic equipment is the result.

R. J. Simes: In answer to the questions of Mr. Wise, may I say that he has mentioned one of the important factors to be considered in the selection of this method of control. That is the simplicity and ease of connecting electrically, the master controller located in the pulpit and the remotely located solenoids. However, this is not the only feature to be considered in selecting, between the use of three mediums or two mediums for this type of control system.

Mr. Angel in his remarks has pointed out another important feature in favor of the use of three mediums. This feature alone could be considered important enough to warrant a decision in favor of the three medium system. That is the similarity or sameness of all controls the operator has to manipulate in his pulpit. I feel that having all master switches instead of some master switches and some hand operated valves tends toward more efficiency on the part of the operator. Where speed is essential, or increased speed is desirable, the possibility of improved production records make this feature one to be given deep consideration.

In addition to the above features, I feel that some consideration should be given the flexibility of mounting electric master switches as against hand operated air control valves. In our installation we found it to be quite simple to locate the master switches, as described in the paper, in a position most suitable from the operator's point of view, for the least amount of effort and energy required on his part. I also feel that from the standpoint of maintenance the master switches will require much less, and less expensive maintenance than would the hand operated air valves.

Another item of importance to be considered in the selection between the two and three medium method is the maintenance of the hydraulic valve. With the three medium system, as described in the paper, the hydraulic valve will always complete its stroke, that is from center to one end in one full stroke, or from center to the other end in like manner. This, we have found from experience tends for longer valve life and much less maintenance than can be expected if the valve is so controlled that it can be inched or moved only part of a stroke and then reversed, as would be the case with a hand operated air control valve.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Open Hearth Dust Control

By STEPHEN VAJDA
Staff Engineer — Steelmaking
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

. . . . of the various units tested, only three gave stacks which are acceptable under existing codes . . . .

▲ IN 1949, the Jones & Laughlin Steel Corp. decided to expand its steel production facilities at the Pittsburgh works with the installation of eleven new 250-ton open hearth furnaces. Although not required to do so at this time, J & L promised the City of Pittsburgh that it would install some type of dust collector on one of the furnaces, after determining by test and practice, the best type of cleaner to install.

Up to that time, no gas cleaning unit had been operated on any open hearth in the country. In fact, the only experimental work done was that performed with an electrical precipitator at Columbia Steel, at Torrance, Calif.

The electrical precipitator is the most expensive type of cleaner on the market. In addition, the character of the open hearth dust is not changed much during the collecting process, so that the disposal of the dust is almost as much of a problem as its collection. Our management, therefore, authorized a series of experiments to try to find a cheaper and better means of cleaning the gases.

GENERAL

At present, there are six basic types of gas cleaning units available. These include:

1. The bag filter which uses the fibres of a cloth bag to stop the dust particles. This causes a layer of dust to build up and act as a filter to clean the gases. Bag filters are used successfully in foundries.
2. The mechanical collector which imparts a circular motion to the gases causing the dust to be thrown out of the gas stream by centrifugal force. Mechanical collectors are used on boilers.

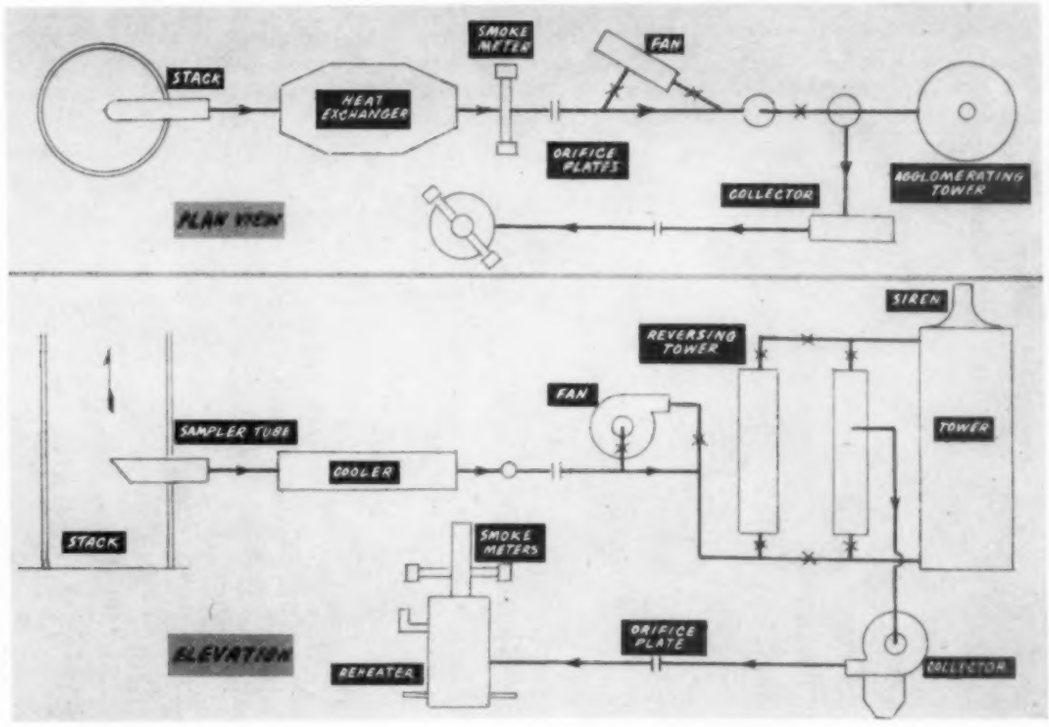


Figure 1 — Schematic layout of setup for experiments on determination of open hearth dust.

TABLE I

Methods of Cooling Stack Gases*

Type of cooling	Water required, gpm	Volume, cfm at 500 F	Induced draft fan, bhp	Cleaning efficiency required, per cent
Heat exchanger	2090	59,100	98	97.5
Waste heat boiler	? Cap.	59,100	98	97.5
Air dilution	....	192,000	417	92.5
Spray cooling (Tower required 20 ft diam x 35 ft high)	57	77,400	129	96.8

*NOTE: Above figures are based on 114,400 cfm at 1400 F cooled to 500 F with an inlet dust loading of 2.0 grains per cubic foot at 60 F, and an outlet loading of 0.05 grains per cubic foot at 60 F. Inlet water temperature for heat exchanger is 95 F and outlet is 125 F. Water temperature for sprays is 80 F. Air temperature is 100 F. Assume a static pressure of 8 in. H_2O for the system.

3. The washer or scrubber which depends on high velocities to atomize the water and wet the dust particles. Washers are used to clean blast furnace gas.
4. The sonic or ultrasonic units which create sound waves in a closed chamber, thus causing the dust particles to collide and agglomerate. Sonic units are used successfully on molybdenum oxide fumes.
5. The electrical precipitator which imparts an electric charge to the dust particles passing through its field. The charged particles are then collected on a plate. Precipitators are used on coke oven gas.
6. The pebble filter which has a bed of granular material moving transversely across the path of the gases. The dust impinges on the pebbles and collects on the surface and in the cracks. Pebble filters are used successfully on incinerators.

The tests run on the open hearth dust included representative units of all types except the bag filter and washer. The bag filter was not tested because the installation to handle our large gas volume would be very bulky and the maintenance would be too high. A true washer or scrubber was not tested because of the stream pollution and corrosion problems. A test was run on the Type "N" Rotoclone which is a modified washer and has very little excess water to be disposed of.

Present city and county smoke ordinances state that a stack will not discharge gases with a dust loading in excess of 0.454 grains per cubic foot at 60 F with 50 per cent excess air. Existing stacks are within this limit more than 80 per cent of the time. Experiments on the bessemer dust and those on open hearth dust on the West Coast indicate that the outlet dust loading must be down to 0.05 grains per cubic foot to give a clear stack. Above this loading, a bystander cannot tell whether there is a cleaning unit on the stack or not.

The problem of cleaning open hearth gases is further complicated by the necessity of cooling them. The flue gases may arrive at the base of the stack with a temperature of 1400 F. There are four possible ways of cooling the gases:

1. Heat exchanger.
2. Waste heat boiler.
3. Air dilution.
4. Spray cooling.

The water and power requirements, the gas volume at 500 F and the cleaning efficiency are tabulated for each method in Table I. Other things to be considered are:

1. *Heat exchanger.* Maintenance — moisture condensation on the cool tube walls will permit the dust to build up. The cooling water will drop its suspended chemicals as a scale.
2. *Waste heat boilers.* This is the ideal set-up — enough steam can be generated to cancel the open hearth requirements. At present, we have enough steam to take care of our present and future needs. The maintenance problems may be less acute than those of a heat exchanger because of the smaller temperature differential.
3. *Air dilution.* Maintenance — most trouble-free of all four types. However, the gas volume more than doubles — thus increasing operating costs with a larger induced draft fan.
4. *Spray cooling.* Initial cost — next to air dilution. This is the cheapest type of cooling. It has the disadvantage of increasing the moisture content of the gases. If condensation becomes excessive a corrosion and dust build-up problem automatically appears. If the moisture does not condense in the equipment, it will in the stack. The gases may have to be re-heated before entering the stack. Even then the moisture may condense on leaving the stack and spray the surrounding buildings with a corrosive mist. In addition, to keep the run-off water to a minimum, a very large chamber is required to vaporize the spray — in our case a 20 ft diam tower approximately 35 ft long.

TESTING SET-UP

All tests were run at the stack of the No. 19 furnace of the No. 3 open hearth shop at Pittsburgh works. This is a tilting type furnace producing an average of 225 tons per heat with an average fuel rate of 425 gal of tar per hour. On some of the tests, oxygen was used for combustion. Oxygen was used for lancing at the end of all heats to reduce the carbon.

Different types of heats are made in this furnace such as: regular scrap, duplex, semi-duplex, etc. As a result, the dust characteristics and loading varied considerably

as did the duration of the different parts of the heat. Tests have shown over 110 per cent excess air at the base of the stack for this furnace. Consequently, the dust concentrations are very low — approximately 1.0 gr per cu ft maximum. The new furnaces are expected to have 25-60 per cent excess air.

Figure 1 is a layout of the equipment as finally installed. The gases were drawn out of the stack with a movable scoop through a gas-to-water heat exchanger by an exhaust fan at a maximum rate of 3000 cfm and discharged into the cleaning unit being tested. The clean gases then went through a reheater into a stack.

Figure 2 shows the connection to the stack and the gas cooler. The 20-in. sampling tube had a 45 degree cut on the intake end and could be moved in or out of the stack to insure getting a representative sample. Hydraulic water was used on the heat exchanger to reduce the gas temperatures to as low as 300 F. Figure 3 shows the remaining equipment.

The reheater equipped with coke oven gas burners was added with the thought of keeping the gas temperature at the outlet smoke density meter the same as that of the inlet. This was good in theory, but it was found that other factors such as dust color, shape, size, etc., and steam and water vapor prevented the recorder readings in each test or of different tests from being directly comparable. The only comparable indices are the grain loadings which can be superimposed on the meter readings. Ultimately, the chief function of the reheater became the reduction of excessive condensation in some of the tests.

In the sonic test by means of a series of goggle valves and two towers, we were able to make the gas flow up or down in the agglomerating chamber. All cleaning units used the same set-up except that these towers and the chamber were short-circuited.

Throughout the entire experiment, an attempt was made to reduce the uncertainties of the human element by using recording instruments. Smoke density meters were placed in the clean and dirty gas lines and connected to recorders. Orifice plates to measure flow were placed in the same lines and also connected to recording flow meters. The differences between the two volumes gave us a check on the amount of air and steam or water vapor added into the system. Meters were also placed on the water, steam and air supply lines. The latter two also had recorders. Ten iron-constantan thermocouples were inserted throughout the system and connected to two five-point temperature recorders. All recorders were mounted on a central panel board. Figure 4 illustrates the various recorders.

Eleven manometers were used to give an indication of the pressure drops across the various parts of the system. They served as a check on clogging in the various sections. Figure 5 shows the manometer board.

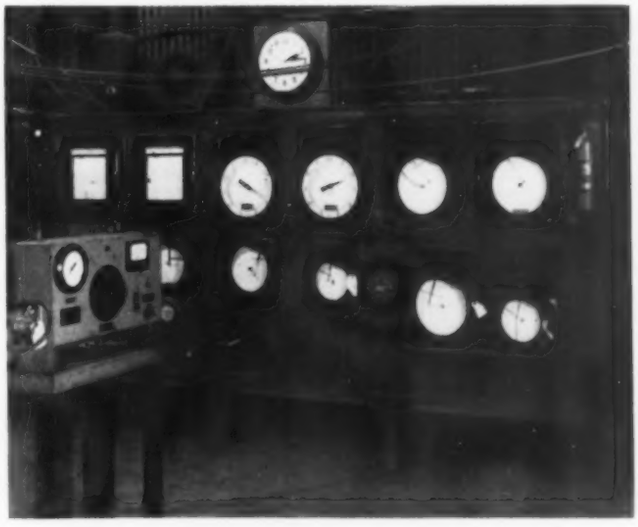
Dust samples were taken with a Brady paper thimble. This is essentially a "grab" method of dust sampling, to find the dust load in the gases. A measured volume of gas is drawn out of the duct by a sampling tube and pulled through a paper thimble, which collects the dust. The thimble is dried and weighed before and after the sampling. Knowing the volume of the gas sampled and the weight of the dust collected, the loading per cubic foot can be calculated.

In some tests a heater had to be used on the sampling

Figure 2 — Connection between gas and stack cooler.

Figure 3 — Overall view of test equipment.

Figure 4 — A battery of recorders was used to obtain the data.



line, and in others, a condenser. In the beginning 15-minute samples were taken, but the dust loading was so light and the results so erratic, that the time was increased to one hour. Excess dust is made during three parts of a heat — during the meltdown and hot metal addition, toward the end of the ore boil, and at the end of the heat during carbon reduction with an oxygen lance. An attempt was made to take simultaneous inlet and outlet dust samples during each of these periods. Both wet and dry type meters were used. At first, vacuum pumps were tried but they quickly broke down. Compressed air aspirators made from pipe fittings were substituted.

TEST NO. 1 — SONIC UNIT WITH TYPE "D" ROTOCLONE

The first cleaner tested was the ultrasonic unit. This consisted of a siren run by air or steam; an agglomerating chamber in which the dust particles are exposed to the sound waves; a misting nozzle which adds water particles in the above chamber — thus increasing the probability of the dust particles colliding and agglomerating; a secondary cleaner which separates the agglomerated dust from the gases.

The term ultrasonic is a misnomer. The range of the siren is 0 - 2.2 kilocycles which is a very shrill sound. It must also be pointed out that the sonic unit does not collect any dust — its sole object is to make the dust particles larger so that a secondary gas cleaner will be able to collect the dust more efficiently.

The first collector tested with the sonic unit was a Type "D" Rotoclone. This is a combined exhauster and dust separator using the centrifugal force imparted by the fan blades to separate the dust from the gases. Figure 6 shows the principle of operation. Several tests were run with the Type "D" alone — both with and without steam and water added to the system — so as to be able to determine the actual effects of the siren.

The siren was run with air at 9-15 psig and later with steam, with the thought that the steam might help agglomeration. For this same reason, steam or water and air were injected in various parts of the system. Exploratory runs were made during which the sound frequency and air pressure were varied. A false bottom was placed in the agglomerating chamber to vary its length and thus vary the sound intensity. At first, no special precautions were taken to insulate the system against the sound waves, but the noise proved so objectionable that testing had to be stopped and the equipment was covered with hair felt.

From this test, it was learned that:

1. The cleaning efficiency for the sonic unit with or without the Type "D" was approximately 20 per cent without steam or water — approximately 55 per cent with steam or water added.
2. The gas-to-water heat exchanger must be kept absolutely dry. If excess moisture in the gases condenses, the tubes become coated — thus losing efficiency and eventually clogging the unit. The gas must pass through the tubes to facilitate cleaning.
3. The dust wets very readily with steam or water.

Figure 5 — Pressure drops were determined by manometers.

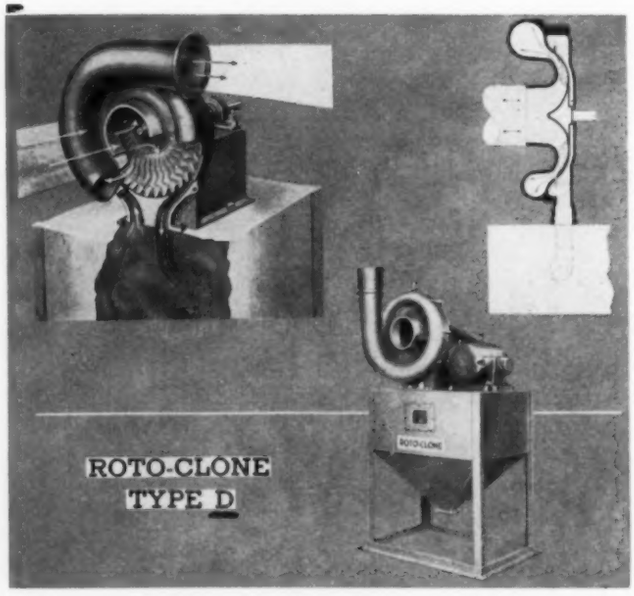
TEST NO. 2 — SONIC UNIT WITH TYPE "W" ROTOCLONE

Although J & L was not interested in a wet collecting system, they permitted the Ultrasonic Corp. to run tests on it. A Type "W" Rotoclone is similar to a Type "D," except that water sprays have been added to wet the dust particles and wash the fan blades. Figure 7 gives several views of the Type "W."

The set-up was identical to the previous test. The Type "W" uses water in its sprays at 40 psig. Water was also injected at the base of the agglomerating chamber. The dust was collected as a slurry. Ultrasonic used their own light meters to measure the smoke density and had the Brady thimbles weighed according to their own directions.

Data from this test indicates:

Figure 6 — The first collector tested consisted of a sonic unit with a type D rotoclone.



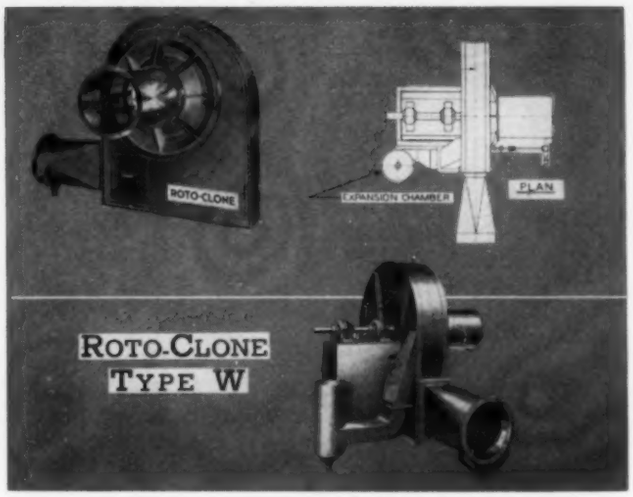


Figure 7 — The sonic unit with a type W rotoclone showed an efficiency of 90 per cent.

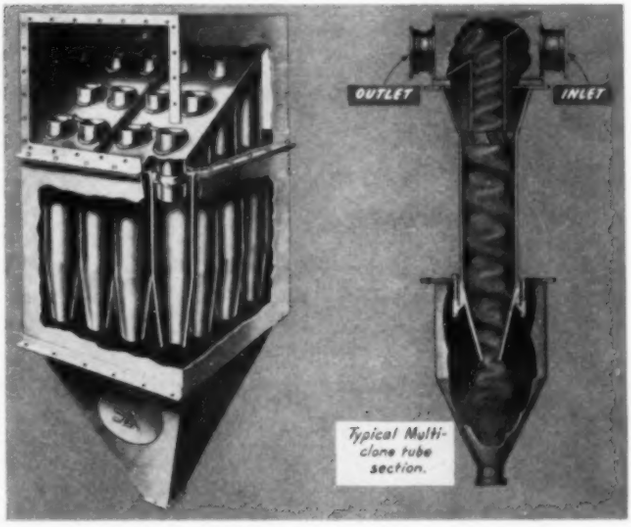
1. Ultrasonic shows an efficiency of 90 per cent for this combination — based on one Brady sample. The Type "W" Rotoclone alone has an efficiency of approximately 45 per cent.
2. A modern gas washer would give us the same end product — slurry.
3. Condensation in the stack was excessive. The clean gases would have to be reheated.

TEST NO. 3 — MULTICLONE

A Multiclone is a cyclone type tube collector with inlet guide vanes which impart a circular motion to the gases. The dust separates from the gases by centrifugal force and collects at the bottom of the tube. The tubes are 6 or 9 in. in diam and the desired capacity is obtained by grouping them in clusters. A 2-tube unit with 6 in. diam tubes was tested. Figure 8 shows the principle of operation and a cluster of tubes.

The unit showed such surprisingly good results on bessemer tests (76 per cent efficiency) that it was decided to try it on the open hearth gases. A pressure drop of 4 in. H_2O was carried across the unit. The manufacturer recommends dropping this to 2½ in. H_2O, stating that the increase in efficiency gained by the higher drop does not justify the additional cost of operation.

Figure 8 — A cyclone tester gave much better results on the bessemer than on the open hearth.



Data from this test accented the following:

1. The unit was good for only 43 per cent efficiency with a 4 in. H_2O pressure drop.
2. A mechanical collector by itself will not give sufficient cleaning. It could possibly be used in series with a precipitator to reduce the load on the latter. Later discussions with the precipitator people revealed that this was not feasible. The precipitator size is determined by the exposure time required by the smallest dust particles. Removal of the large particles is of no particular help with our light dust loads.
3. Its major advantages are: trouble-free operation, no adjustments to make, no controls to operate.

TEST NO. 4 — TRION PRECIPITATOR

A high voltage electrical precipitator consists of an electrode which imparts an electrical charge to all the dust particles and a plate or pipe which attracts these charged particles. The dust is removed from the plates by rapping, from the pipe by washing. A substation is required to house the transformer which changes the voltage to 50,000-75,000 volts, and a rectifier which changes the a-c current to d-c. Figure 9 shows a typical precipitator setup.

There are two types of precipitators on the market: (1) A heavy-duty, industrial type, using voltages from 50,000 to 75,000; (2) a commercial type using 12,000 to 15,000 volts. The Trion is of the latter type. With the lower voltages, no large transformer or rectifiers are required, and no elaborate substation. The power is furnished by a compact power pack. Figure 10 shows the Trion unit tested.

The reasons for testing this unit were twofold: (1) To find the characteristics of the dust collected by an electrical precipitator; (2) to find out if the higher voltages were necessary for our light dust loads. For the first few tests, the unit was run continuously without rapping with no appreciable arcing.

The following data was collected from this test:

1. There is a very marked improvement between the clean and dirty stacks — an efficiency of approximately 80 per cent. Occasional dust puffs in the clean stack would seem to indicate that the unit was at its capacity — even though being used at only 33 per cent rating.
2. Although on small installations the small power pack is very attractive, it does not prove so on large units. The installation on our furnaces would require at least forty-eight separate cells and power packs.
3. The dust agglomerated into larger particles very nicely and did not remain in its original state as was feared.

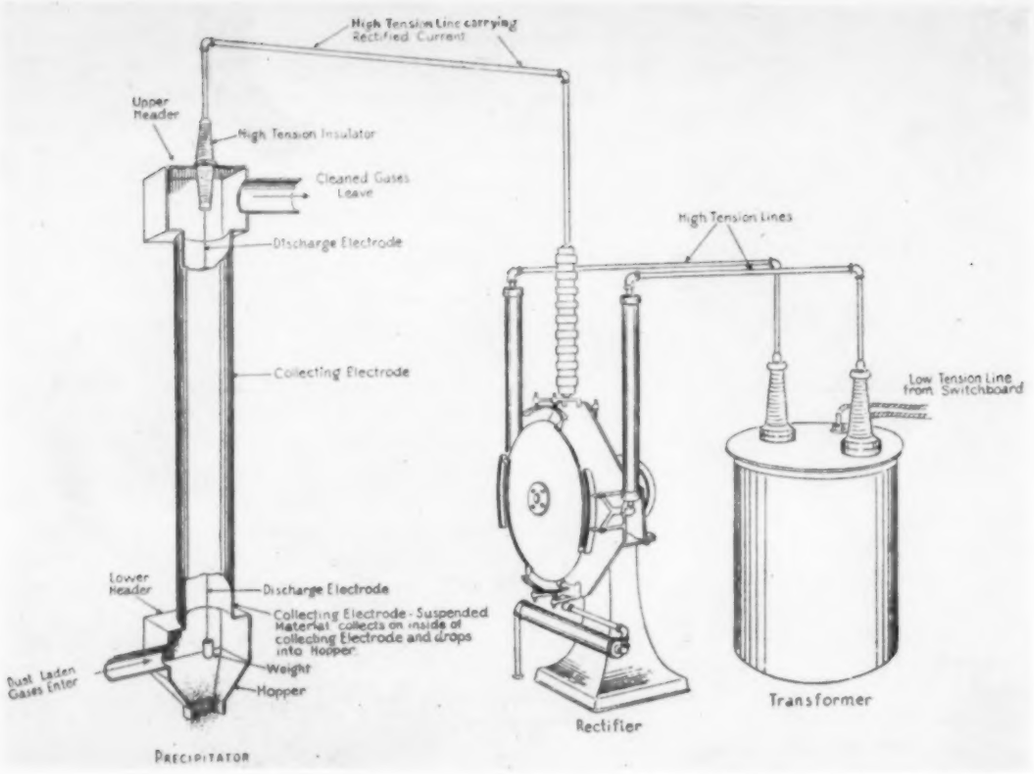


Figure 9 — Schematic of typical precipitator set up.

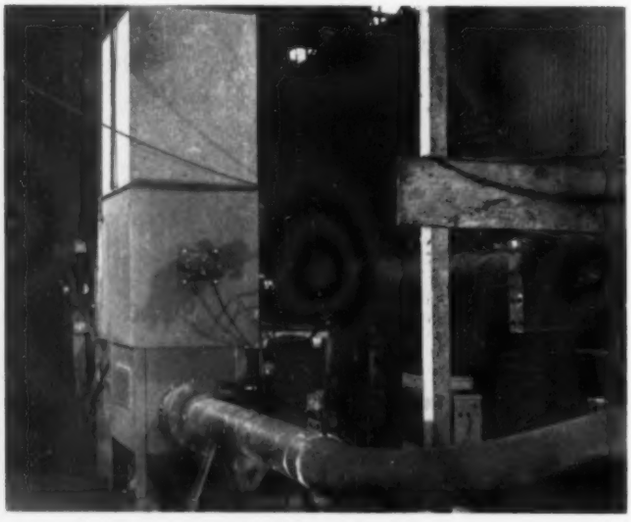
TEST NO. 5 — TYPE "N" ROTOCLONE

A Type "N" Rotoclone is a combined exhauster and dust separator in which the cleaning action is obtained by washing the gases with a water spray created by the gases whipping through vanes immersed in a standing body of water. A simple drag chain can be used to scrape the dust out of the hopper. Figure 11 shows the principles of operation.

This unit was tested because it offered the possibility of the advantages of a gas scrubber without the disadvantages of recirculating or cleaning the dirty water. It eliminates the need for cooling the gases. It is compact in that it combines both a cleaner and an exhauster. Figure 12 shows the unit tested.

A pressure drop of 4 in. H_2O was carried across the unit. In four weeks, the water eliminators were completely corroded away. Then the guide vanes and the inspection door began to corrode. Soda ash was added to neutralize the free acid, but the H_2SO_4 equivalent of the total Fe kept increasing. Figure 13 shows the corroded water eliminators.

Figure 10 — Illustration shows precipitator unit tested.



The unit showed enough promise that the General Technical Department asked the manufacturer to design a filter which would replace the water eliminators. It was hoped the filtering action would increase the efficiency enough to produce an acceptable stack. They designed a filter pad 8 in. thick filled with fine strands of twisted wire. The wire corroded very quickly and only a few tests were run. The increase in efficiency was not satisfactory.

The Design Engineering Department then made up a filter pad 4 in. thick filled with gravel ¼ to ½ in. diam. Sufficient water hit the filter so as to eliminate the need for back-washing. This pad increased the pressure drop to 6.2 in. H_2O.

Data from this test indicated:

1. The standard Type "N" Rotoclone was good for approximately 50 per cent efficiency. The use of the wire filter increased this to 57 per cent and the gravel filter to 66 per cent.
2. The dust did not build up into a thick slurry in the water. It settled out and was easily scraped out by a simple drag chain. The dust after a week or so in the discharge hopper becomes a heavy clay-like substance with no excess water, even though it has been covered by water during that period. The dust will settle out in 15 to 20 min in still water.
3. There is excessive corrosion in the unit. The unit could be lined with concrete to overcome this.

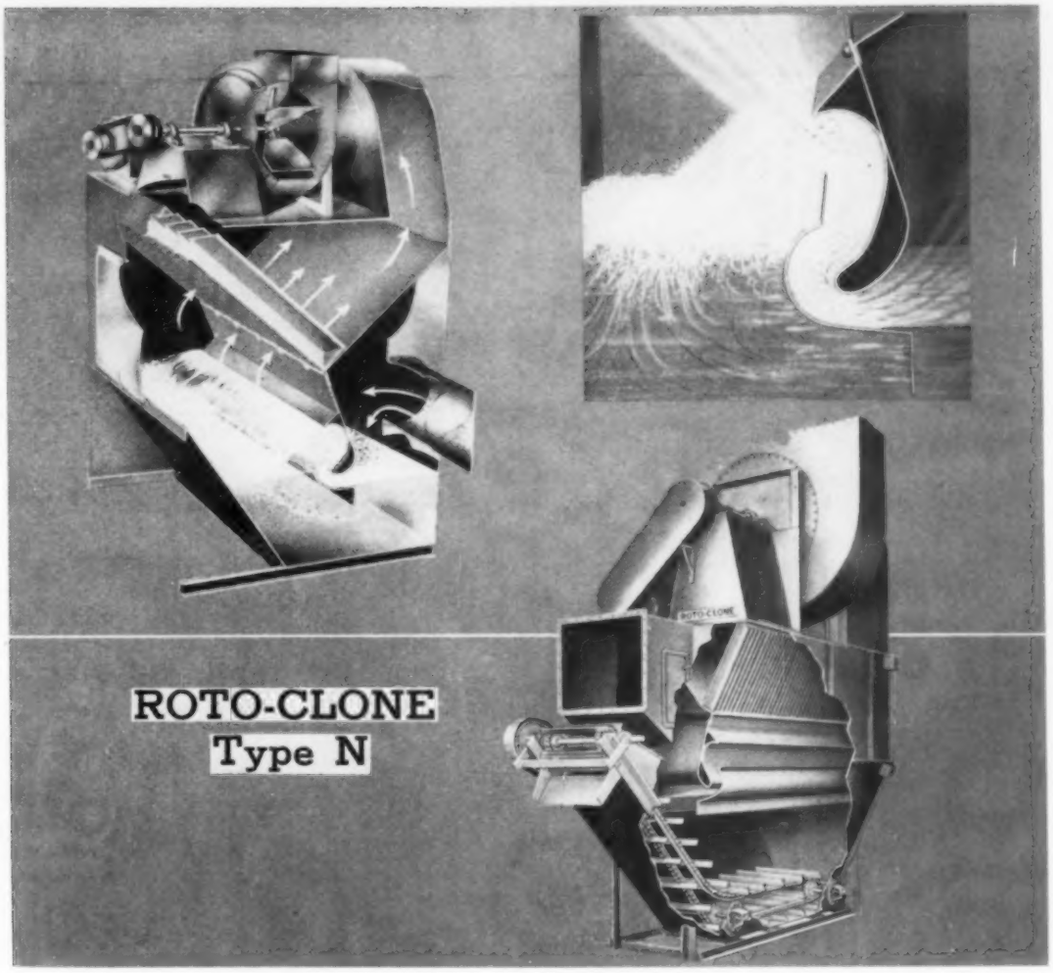


Figure 11 — The principle of operation of the combined exhauster and dust separator is shown in these schematic illustrations.

4. There is excessive condensation in the stack which could prove very disastrous, even though the stack is lined with brick. Reheating the cleaned gases could possibly overcome this objection, although it is very likely that the corrosive mist would be sprayed on the surrounding buildings.

TEST NO. 6 — IMPINGO PEBBLE FILTER

An Impingo unit is a simplified "Lynch Pebble" type filter in which gases pass through two or more moving beds of granular material. The dust is caught in the holes and cracks in the surface of the filter media. Figure 14 shows the unit tested.

Double burnt dolomite (⅛ to ½ in.) was used as the filter media with the thought of putting it back into the open hearth. The excessive sulphur killed this idea. The next thought was to use coke breeze and charge it into the blast furnace. This idea was dropped because the breeze is too fine to charge into the furnace and too coarse to sinter. It would have to be crushed — an extra materials handling job and also a dust problem. A cheap material like crushed air-cooled slag could be used, cleaned on a vibrating screen and recharged into the unit. The experiment was too short to determine how many times it could be re-used and then thrown away.

The gases passed through two 4-in. beds of dolomite which were moved only enough to maintain a 6-in. H_2O pressure drop across the units. At this rate, about 30 tons of material would have to go through the unit per day on a standard furnace. Of course, this might be 5 to 10 tons being used over and over.

Test results show that:

1. Despite the high efficiency of 78 per cent there still are dust puffs in the clean gas.

Figure 12 — The type N rotoclone is shown as it was set up for the test.

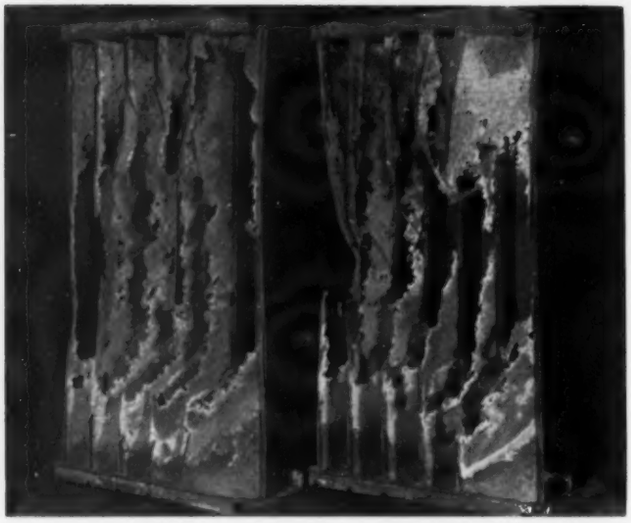


Figure 13 — One of the problems found with this type of equipment was that of corrosion.

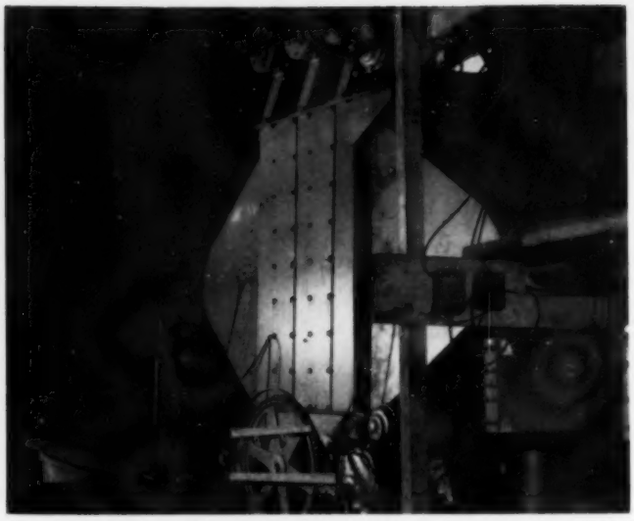


Figure 14 — In the pebble type filter, the gas is passed through two or more moving beds of granular material.

2. The efficiency of the unit could be increased by simply slowing the rate of flow of the filter media. This means more fan horsepower and we already had 6-in. H_2O drop across the unit.
3. The bucket elevator, screw conveyors, vibrating screen and rotary valves might become a serious maintenance problem.
4. The handling of the filter media would be an additional operating chore.
5. The dust would not be in as good condition to handle as either from the Type "N" Rotoclone or the precipitator.

SUMMARY

The chemical analysis of the dust shows the iron content (58.9 per cent) to be higher than present day ores. But the sulphur is too high for our low sulphur open hearth practice. Sintering and charging into the blast furnace is an alternate to throwing it away.

An analysis of the particle size shows that 55 per cent

TABLE II

Brady Sampling Results

Unit tested	Number of samples	Dust load, gr/cu ft @ 60 F				Average efficiency, per cent
		Inlet		Outlet		
		Maximum	Minimum	Maximum	Minimum	
1. Sonic with Type D Rotoclone (No steam or water added)	4	0.4145	0.207	0.267	0.164	20.3
2. Sonic with Type D Rotoclone (Steam or water added)	10	0.4198	0.009	0.1661	0.002	53.8
3. Type D Rotoclone (No steam or water added)	5	0.468	0.036	0.408	0.033	22.8
4. Type D Rotoclone (Steam or water added)	10	0.6151	0.1657	0.3721	0.0518	55.4
5. Sonic with Type W Rotoclone (Water added in tower)	1	0.196	.....	0.0183	.....	90.7
6. Type W Rotoclone	3	0.487	0.253	0.188	0.170	45.1
7. Multiclone (4 in. H_2O pressure drop)	5	0.3854	0.0924	0.230	0.0440	43.4
8. Trion precipitator	10	0.4236	0.1072	0.1411	0.0029	80.7
9. Type N Rotoclone (4.0 in. H_2O pressure drop)	9	0.3334	0.1272	0.1289	0.0657	49.6
10. Type N Rotoclone with wire filter (4.6 in. H_2O pressure drop)	6	0.3591	0.1870	0.1423	0.0817	57.1
11. Type N Rotoclone with gravel filter (6.3 in. H_2O pressure drop)	8	0.3082	0.1006	0.1377	0.0103	65.7
12. Impingo (pebble filter) (4.6 in. H_2O pressure drop)	12	0.7303	0.0284	0.2519	0.0089	61.5
13. Impingo (pebble filter) (6.0 in. H_2O pressure drop)	9	1.0828	0.1127	0.1793	0.0236	77.8

of the dust is less than 5 microns with 50 per cent less than one micron. The experiment proved all fears about the dust remaining in its original fine state after passing through a precipitator were unfounded. The particles agglomerate into large balls, but they are still light enough to be blown around, if exposed to air currents.

Table II is a comparison of Brady sampling results. Of all the units tested, only three gave stacks that are acceptable under existing codes:

1. Impingo pebble filter.
2. Electrical precipitator.
3. Sonic unit with Type "W" Rotoclone.

DISCUSSION

PRESENTED BY

C. A. BISHOP, Research Associate, United States Steel Co., Pittsburgh, Pa.

D. L. DeVRIES, Koppers Co., Inc., Baltimore, Md.

EMIL KERN, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

H. S. HALL, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

STEPHEN VAJDA, Staff Engineer — Steelmaking, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

C. A. Bishop: The one question I have concerns the remark that you expected to put the recovered dust through your sintering plant. Do you expect to get an appreciable amount of the dust going back out through the sintering plant stack?

Stephen Vajda: Tentatively it seems that the best thing to do would be to put it through a pug mill of some kind so that it will not be blown all over the countryside while shipping it to the sintering plant. After we get it there, we hope to be able to mix it, one-third part with the blast furnace dust from the downcomers and dust-catchers, and one-third part with the sludge from the thickeners. In that way we hope to be able to get it into large enough particle sizes so that it will not blow out the stacks.

D. L. De Vries: Since the Fairless plant is located across the river from Trenton, clean stacks are being given serious consideration. The degree of cleanliness is somewhat lower than the 0.05 grains per cubic foot which has been discussed here tonight, and is based on an inlet loading of approximately 2 grains.

Each open hearth furnace at the Fairless plant will be equipped with two electrostatic precipitators. Since there are 9 open hearths, there will be a total of 18 precipitators. By having two precipitators on each furnace, by-passing of one unit can be accomplished. While by-passing, the flue gases are still being cleaned. This is the same arrangement as that proposed for the J & L installation.

Emil Kern: In our examination of the dust nuisance at our Brackenridge plant, we found that the dust emitted from our open hearth and soaking pits was only approximately five per cent of the total dust nuisance.

Smokewise, or when the color of smoke is darker than Ringlemann No. 2, we find only 33 per cent can be blamed on our open hearths.

When we analyze what it costs to clean up the open hearths, we find that we have to expend a rather large sum in comparison to what it costs to clean up locomotives or boiler houses and the like.

For instance, figures compiled by the Industrial Hygiene Foundation, showed that our boilers emit 76.8 per cent of the total fly ash, our locomotives and locomotive cranes about 15 per cent, and our open hearths and soaking pits together only about 5 per cent. Costwise we find that the open hearths take the greatest amount of money to clean up. I have often wondered whether other plants have made similar investigations.

H. S. Hall: I would like to discuss mainly methods of cooling stack gases, particularly by air dilution.

Mr. Vajda stated in his paper and showed in Table I that the volume of gases it would be necessary to handle at 500 F by the air dilution method would be 192,000 cfm and that the induced draft fan brake horsepower would be 417. We presume that this volume of gases was calculated from the data obtained during the experiment when 425 gallons per hour of tar was being burned as fuel on their No. 19 furnace.

The modern open hearth furnace should not have an exit gas temperature from the checker chambers of anywhere near 1400 F. The exit gas temperature should be more on the order of 800 to 900 F if the checker chambers are of adequate capacity and properly designed.

By the use of our furnace control system, with secondary regenerators, we are able to obtain exhaust gas temperatures of this order and in so doing we return considerable more heat to the furnace in the form of higher preheated air which cuts down fuel costs and raises furnace melting capacity which reflects in tons per hour.

Figure 15 shows the checker temperatures of a 175-ton cold pig iron furnace which has an average exhaust temperature of the flue gases of about 850 F.

In the design of the system, we of course use cold air for ejection purposes and this air dilutes the outgoing gases from the checkers sufficiently to reduce the temperature of these gases to the required 500 F or less. In fact, in the design of this furnace control system or a furnace with a fuel input of 600 gphr of oil, with the flue gas temperature of 850 F leaving the secondary checkers, and producing 2 in. of draft on top of these checkers, the temperature of the flue gases and ejection air going out the top of the ejectors would be 455 F and the actual volume at this temperature would be 79,000 cfm.

The horsepower required by the ejection air fan would be 69 hp. This would furnish the air for dilution and also provide 2 in. draft for the furnace.

It is our understanding from the manufacturers of electrical precipitators that the draft loss through a precipitator is in the order of ½ in. water. A fan capable of handling 100,000 cfm at 500 F and producing one-in. draft would require 30.8 hp. This, plus the 69 hp required by the ejector, amounts to 99.8 hp instead of the 417 hp as given by Mr. Vajda in his paper. It is comparable to the fan horsepower (98 hp) given for the heat exchanger and the waste heat boiler which, we

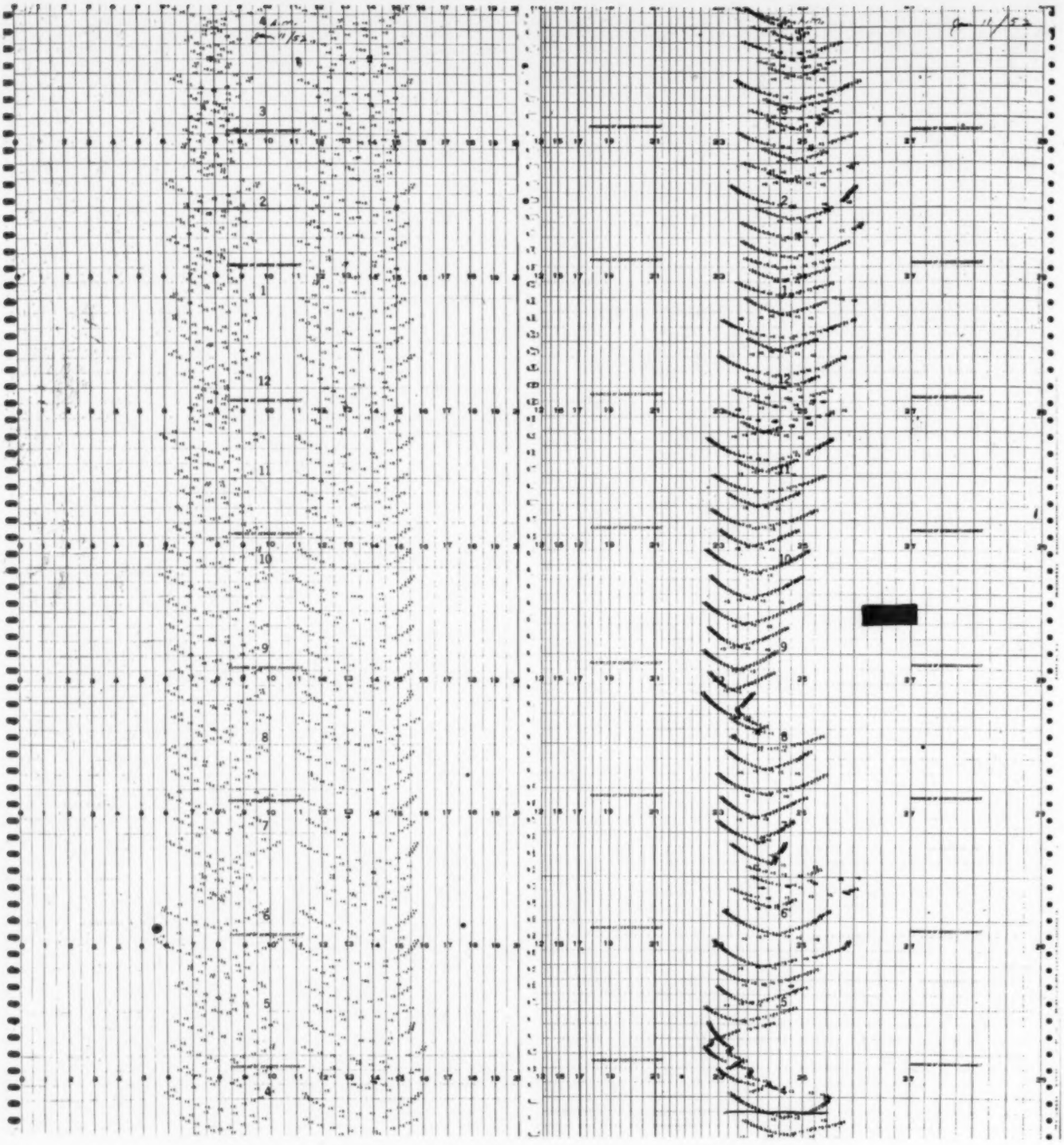


Figure 15 — Checker temperature of a 175-ton furnace using cold pig iron.

presume, were based on the 425 gphr of tar which was being burned and which would, no doubt, go higher, probably to 150 hp, if the fuel input of the furnace were on the order of 600 gphr of oil.

From the above, it appears that cooling by air dilution is much more economical of horsepower than any of the other methods suggested.

Stephen Vajda: The volume of gases to be handled is based on burning 800 gallons per hour of tar with 80 per cent excess air and using oxygen for burning 200 of the above gallons.

Stack temperatures vary throughout the heat and also with the excess air. Temperatures of 1100 to 1200 F are not uncommon on present day furnaces without waste heat boilers. These can be expected to increase as the checkers get dirty or glazed or during a violent ore or lime boil.

Although the actual pressure loss throughout the system (checkers, flues, dampers, heat exchanger, ducts, precipitator, etc.) may be as low as 5-in. H_2O, a fan capable of producing 8 in. at rated capacity was chosen to overcome variations in air volume during the heat, clogging of the checkers, flues, heat exchanger, etc.

REMOTE CONTROL OF AN INGOT BUGGY WITH THREE MOTIONS

. . . . applications of remote control are finding ever increasing uses in steel plant equipment . . . .

By K. S. KUKA
Superintendent
Electrical Engineering and Construction
Tata Iron & Steel Co., Ltd.
Jamshedpur, India

▲ IN a paper published in the June 1948 issue of the Iron & Steel Engineer, a scheme was presented which described a method of remote control of ingot buggies for transporting hot ingots from the soaking pits to the blooming mill. The control described therein was applicable only to the long travel motion of the buggy while the ingot tilting operation was intended to be over the tilting horns, as has been the practice with older designs.

Remote control problems of a modern buggy provided with electrical tilting and the first transfer rolls on the buggy itself, require further consideration, because provision for remote control of the tilting as well as the rolls operation has to be made along with the travel motion. Ingot buggies are often designed such that it is possible to tilt the bucket in either direction so as to make it possible for the ingot to be fed into the mill, either with its top-end first or with its bottom end first, depending on the design of the ingot mould adopted, depending on whether the ingot is extracted or stripped from its mould at the stripper yard.

Figures 1 and 2 give sketches of an ingot buggy designed for tilting the bucket in either direction to allow the ingot to be placed so that either the top end or the bottom end can be fed first into the mill.

Total weight of the buggy is about 100 tons and is designed to take ingots about 26 in. wide and slabs about 44 in. wide, with ingot weights up to 11.5 tons. Traveling speed of the buggy is designed at 500 fpm. The motor for the long travel motion has a capacity of 140 hp at 445 rpm which drives the two 48-in. diam back wheels over a four-thread helical reduction gear with a ratio of 1:10.

The bucket can be tilted in either direction over a worm reduction gear and a crank drive, requiring a motor of about 105 hp.

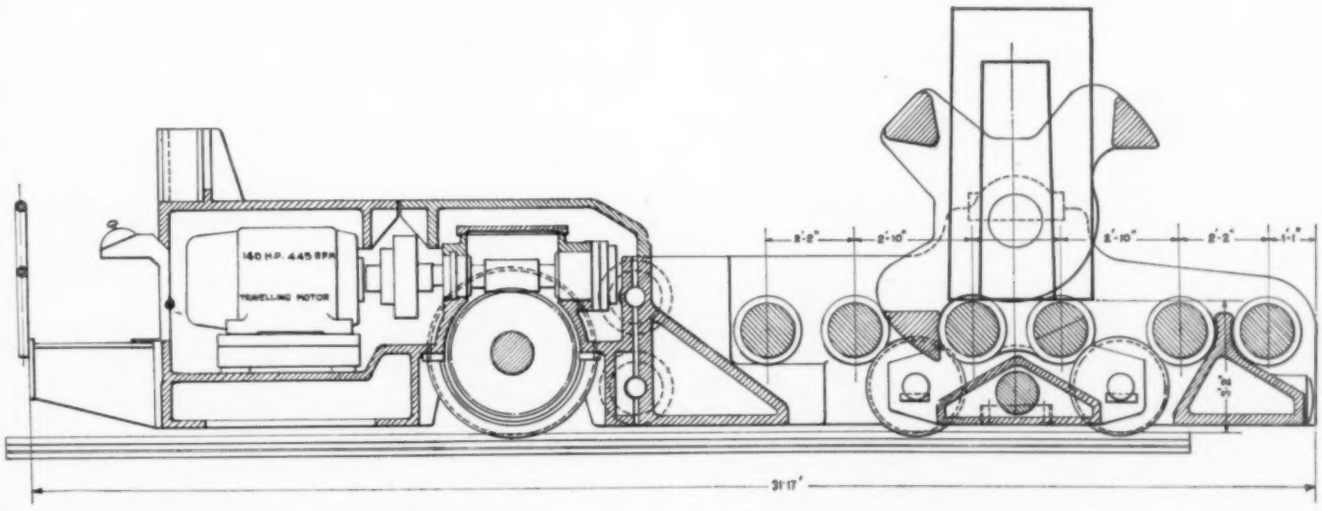
There are six conveyor rollers driven by means of screwgears, the line shaft being driven over a single step reduction gear by a 25-hp, 615 rpm motor. This arrangement has to be adopted because due to space limitations the width of the car has to be kept small.

Control of such a buggy would be easy, if direct operation from a cabin on the buggy itself is provided where an operator can move with the buggy to control it. This would require a trailer on which the driver's cabin can be accommodated with the necessary controls. The conditions of operation are however such that a remote control with the operator situated at a convenient location is the best solution.

The design of the remote control described in this paper is based on the following requirements:

1. Standard constant potential direct current operated rheostatic control is to be used. The control arrangement shall be such that it would be possible

Figure 1 — Side sectional view of a traveling ingot buggy. This equipment tilts in two directions.



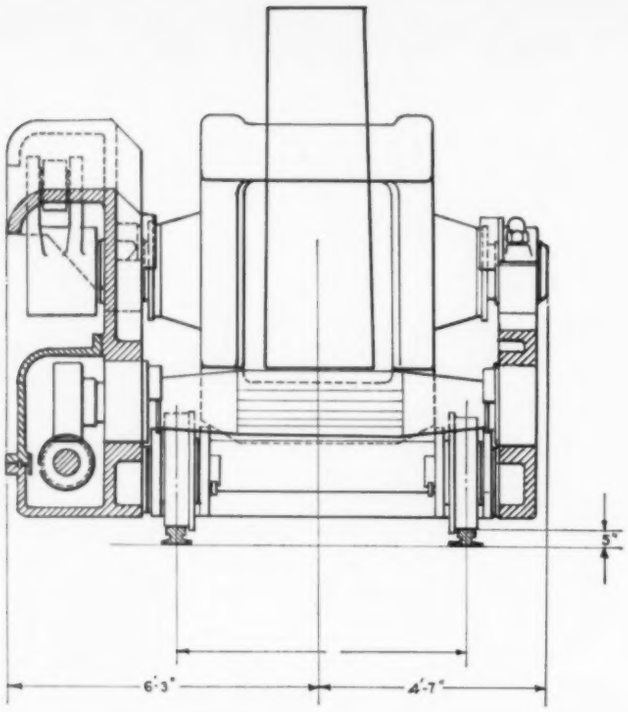


Figure 2 — Sectional view of the buggy showing the bucket.

to keep the buggy in operation in an emergency when one of the power rails develops a ground fault which might make remote control difficult.

2. Minimum number of power rails shall be carried along the building to traverse the whole length of buggy travel, so as to reduce maintenance and troubles during service to a minimum.
3. Protective means shall be provided so that in case a control power rail develops a ground fault, the control is made ineffective in order to prevent over-running of the buggy or its inadvertant starting.

This paper describes a scheme of controls which fulfills most of the conditions of operation desired, and is at the same time simple and straightforward for the operator and maintenance engineers.

The main features of the scheme are as follows:

1. The motors selected are d-c mill type auxiliary motors of the 600 series of AISE standard, however with constant field shunt excitation. Same frame size 140 hp is selected both for the buggy travel and the bucket tilt services.
2. The operator is stationed at a convenient location near the mill approach table from where he can control both the buggy as well as the mill approach table.
3. The control interlocking is such that the buggy can travel only with its bucket in "up-position," while the ingot tilting operation can be carried out only at the mill end, when the buggy stands near the mill approach table. The operation of the buggy transfer rolls is interlocked with the bucket tilt so that the rolls start turning just before the ingot is being transferred on to them.
4. On a tilt-motor selector switch, the operator can select the direction of ingot tilting so as to enable the ingot to be fed into the mill as desired, i.e. with ingot top-end or the ingot bottom-end first.
5. As the control panels and resistances are to be placed on the buggy, it is proposed to select the control such that both travel and tilt motors can be operated in sequence over the same control panels so as to have minimum equipment on the buggy.
6. An earth leakage relay scheme is provided which prevents the system to function, if a permanent ground fault develops either on the control crossbar or on any of the main directional contactor control wires.
7. Emergency master switches can be provided on the buggy which can permit operation of the buggy if for any reason remote control is made ineffective and it becomes necessary to operate the buggy from its own platform.

The system of control is shown in Figures 3 and 4. Figure 3 indicates the connections for the protective panel; Figure 4 gives the diagram of connections for the control panel for travel and the tilt motors. The connection diagram for the roller table is not shown, because it is a simple unidirectional standard control for a d-c shunt motor.

The protective panel is mounted at a convenient location near the operator, whereas the main panel for the traverse and tilt motors with resistances is mounted on the buggy. The control panel for the rolls is also mounted on the buggy. This, being a small self-contained unit, can easily be accommodated at a convenient location near the main panel.

There are on the whole seven crossbars required to control the three motors, two main current carrying crossbars and five control crossbars. Out of these, only five crossbars are required to be carried along the whole travel of the buggy, namely two main crossbars and three control crossbars. Two control crossbars for the control of the bucket tilt motor are required only at the end portion near the mill approach table.

Figure 3 indicates the connections for the protective panel with under-voltage relay, over-current relays and the main power line contactors interlocked with the control master switch, so that the buggy can be operated from stand-still only with the master switch handle in "off" positions. Emergency safety switch and the "Start Stop" push button station are mounted near the buggy operator.

Figure 4 indicates the diagram of connections for a reversing, dynamic braking magnetic control with master switch operation. The main feature of the control is that the same panel is utilized to control two motors of the buggy, alternatively traverse or tilt as desired. The magnetic contactors A10 and A11 control the traverse motor, and the contactors A20 and A21 control the tilt motor, main power being taken over the crossbar collectors MC1 and MC2.

Forward motion controlled by the contactors 1F-2F is taken to be towards the mill, while the Reverse direction controlled by the contactors 1R-2R is taken to be away from the mill, the movement of the buggy being supposed to be in the same center line as the main mill.

To move the buggy towards the mill, the master switch is moved to notch 1 in the direction marked "Forward." This energizes the contactor coils 1F and 2F over the control collector PC1. Closing of contactors

1F-2F energizes the main line contactor M, which in turn energizes the traverse motor armature contactors A10-A11. The traverse motor is thus connected to the line over the armature diverter circuit formed by the normally closed contacts of the spring closed contactor D and all the line resistances R1 to R4. This would give a starting torque to the buggy which immediately begins to accelerate smoothly. Points 1 and 2 of the master switch have the same connections intentionally provided to allow the buggy to accelerate and prevent unnecessary heavy plugging due to inadvertent movement of the master switch handle.

When the master switch is moved to the third notch, the accelerating relay FRR is energized, which removes the armature diverter circuit by energizing the contactor coil D, which opens its contacts D and permits the accelerating contactors 1A, 2A and 3A to be closed over the magnetic time-delay relays 1AR, 2AR and 3AR in sequence. This permits the buggy to attain its full speed smoothly.

When the master switch is suddenly brought to the "Off" position, the relay DR which is a magnetic time-delay relay opens its contacts DR after a time-interval. The relay DR controls the contactors A10-A11 which drop out only after a fixed time delay when the relay DR drops out. This permits the motion to be stopped by the motor dynamic braking action before the series brake resets. Thus a smooth stop of the buggy motion is obtained.

The motor shunt field is provided with a field economy resistance and a field economy relay FF1 which permits the resistance to be introduced in series with the motor shunt field when the motor is not working, thus reducing the heating of the shunt field when the buggy is at stand still.

The bucket tilting motor is selected by the tilt motor selector switch. Depending on whether the ingot has to be fed to the mill with its top-end or the bottom end first, the selector switch handle is turned to position Front or Back. The selector switch gives circuit connections to the coils of contactors A20 and A21 which control the armature circuit of the tilt motor. The contacts 3-4 or 5-6 of the master switch would give the circuit to the tilt motor depending on the direction of tilting selected.

When the selection of the bucket tilt direction is made over the tilt motor selector switch, the main master switch is moved in selected direction, "Forward" for the front-tilting and "Reverse" for the back-tilting. The movement of the master switch handle permits the directional contactors 1F-2F or 1R-2R to close, which then energize the motor armature contacts A20-A21 over the auxiliary contacts of F and R and the tilt-limit switch contacts. The tilt motor thus starts moving which operates the bucket tilting over the mechanical leverage provided.

The contacts 1-2 of the tilt-motor selector switch open out when the selector switch is moved from its "Off" position. This disconnects the relay FRR and prevents the operation of the contactors D, 1A, 2A and 3A. The motor is thus connected over its armature diverter circuit with all the resistances in line. The resistances are so selected that the motor is able to give load torque corresponding to 85-90 hp which is required to move the tilt mechanism. As soon as the bucket shifts from its vertical position, the gravity action comes into play and in order to provide controlled movement, the motor tends automatically to produce dynamic braking action. The effective armature diverter circuit thus permits either motoring or dynamic braking action depending on whether the bucket moves empty or with an ingot. The spring closed contactor D always ensures smoothing tilting of the ingot under all conditions. The electro-mechanical brake is provided for holding the bucket in position. The motor is provided with a shunt field economizing relay similar to the traverse motor.

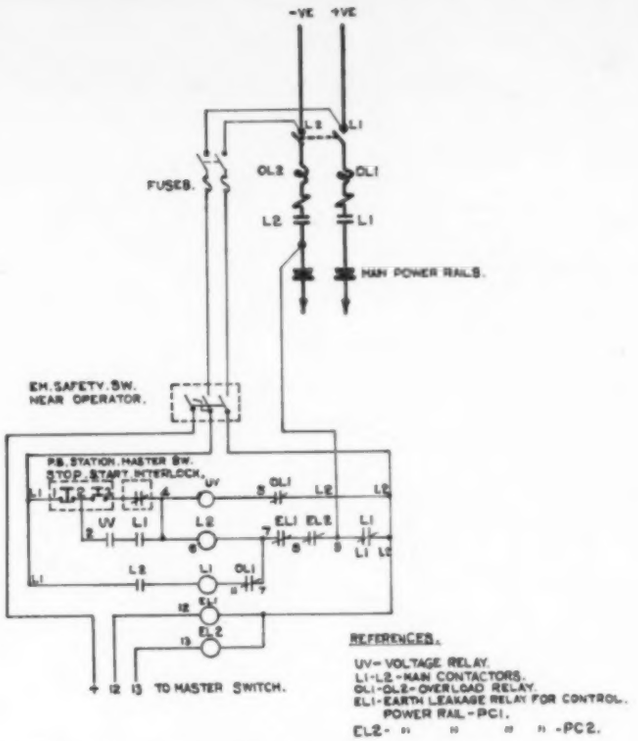

-VE
+VE
FUSES.
MAIN POWER RAILS.
EM. SAFETY SW. NEAR OPERATOR.
PB. STATION. MASTER SW. STOP. START. INTERLOCK.
TO MASTER SWITCH.
REFERENCES.
UV- VOLTAGE RELAY.
L1-L2 - MAIN CONTACTORS.
OL1-OL2 - OVER LOAD RELAY.
EL1 - EARTH LEAKAGE RELAY FOR CONTROL POWER RAIL - PC1.
EL2 - " " " " - PC2.

Figure 3 — Connection diagram for protective panel.

Tilt motion is provided with a geared type cam-operated limit switch with 6 contacts. Contacts 1 and 2 become effective for sequential operation for the bucket tilting in the front direction, i.e. when the ingot is to be placed on the mill table with its top-end first. Contacts 1 remain closed while contacts 2 remain open when the bucket is in its up-position. When the bucket is in its down-position, the contacts 1 open and contacts 2 remain closed. In any intermediate position, both the contacts 1 and 2 remain closed. The operating cams are designed to stop the motor in one or the other limiting position.

Similarly contacts 3 and 4 become effective for the tilting sequence when the bucket is to be tilted in the other direction in order to place the ingot on the table with its bottom-end first. Contacts 3 remain closed in the "Up" position, while contacts 4 remain closed in the "Down" position. The cam design is similar to those for the contacts 1 and 2. The contacts 1 and 3 thus limit the up-limit of the bucket while the contacts 2 and 4 the down-limit. If the bucket is held up in any intermediate position, it can be moved in either direction as desired as all the contacts 1, 2, 3 and 4 then remain closed.

The limit switch contacts 6 close only in the up-posi-

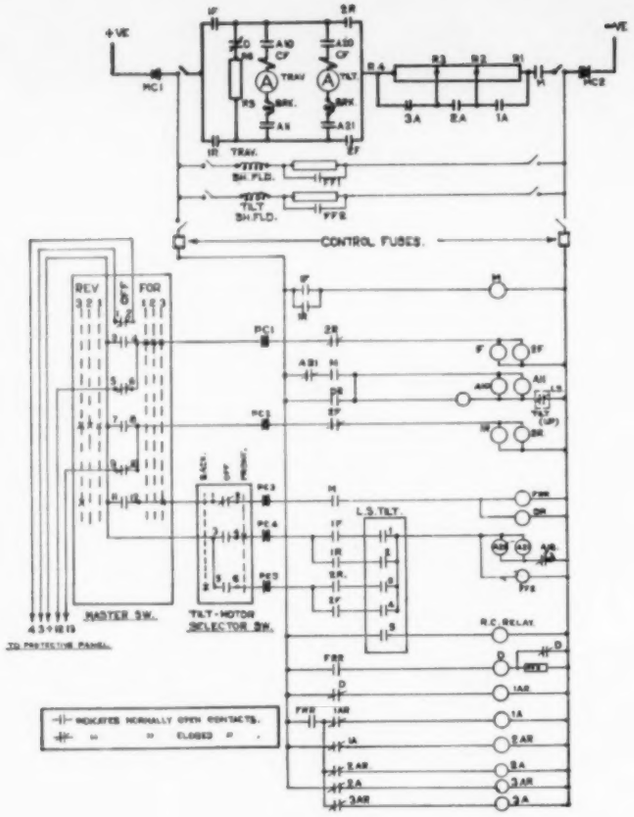


Figure 4 — Connection diagram for control of travel and tilt motors.

tion of the bucket. These contacts control the traverse motor contactors A10-A11. Thus the buggy can move out only when the bucket is brought to its up-position suitable for receiving the ingot from the soaking pit crane.

This interlocking has been provided, because the control crossbar collectors PC4 and PC5 for the bucket tilt service are provided only at the mill approach table end where alone the ingot tilting operation can take place. This ensures that the ingot cannot suddenly be lowered on the buggy table accidently when the buggy is in motion; the proper sequential operation is thus ensured over the tilt limit switch.

The roller table of the buggy is controlled over a separate control panel which functions automatically when the buggy is in its tilted position. The contacts 5 of the tilt limit switch close when the bucket is tilted to a certain position, and the roll motor control relay gets energized. This relay actuates the roll motor magnetic control which operates the rollers which are ready to receive the ingot to be transferred to the mill table. The roller run motor is a 25-hp shunt wound motor and is operated only in one direction to feed the ingot always to the mill table. The control is a simple standard unidirectional automatic magnetic controller for a shunt wound d-c motor provided with shunt field economy relay.

A remote control often becomes a problem if a ground fault were to develop on a control wire or a control crossbar. From Figure 4, it can be seen that if a ground fault were to develop on the control wire rail PC1 or PC2 or on the respective connected wires, and if the d-c network to which the control is connected has already a ground fault on the positive line, the directional contactors if once energized, will then remain closed because the master switch contacts tend to get shorted over the two ground faults. Similarly if the contactor coils get grounded with their own cores, the contacts will remain sealed in once the contactor closes. The motor thus fails to stop over its master switch and has to be disconnected from the circuit at the protective panel.

To provide an automatic protection against such ground faults, the relay EL1 and EL2 are introduced, connected over off-position closed contacts 5-6 and 9-10 of the master switch. It will be seen that the coil of relay EL1 is connected with one terminal to the negative line L2, and the other terminal over the master switch contacts — 5-6 to the point 4 connected to the control crossbar PC1. Similarly the coil of the relay EL2 is connected between the control crossbar PC2 and the negative line L2 over the master switch contacts 9-10. The relay coils EL1 and EL2 thus get the circuit only in the "Off" position of the master switch. If due to any fault, the control power rails PC1, PC2 or their control wires get a positive voltage polarity in the off-position of the master switch due to any fault, the relays EL1 or EL2 will at once be energized which will open their normally closed contacts EL1 or EL2 which control the protective panel main line contactors L1 and L2. Thus the whole circuit is at once disconnected and the buggy brought to a stop. The relays EL1 and EL2 remain energized as long as the ground fault on the control circuit remains, and thus prevents operation of the buggy unless the notice is taken of the ground fault.

In case of a ground fault on one of the control wires or due to any other emergency, if the buggy has to be kept in operation during the interval when the remote control is out of commission, the control system permits the operator continue service from the buggy itself. A duplicate set of master switch and the tilt motor selector switch can be mounted on the buggy platform with suitable changeover switches so that the control can be transferred from remote control to hand control from the buggy.

The changeover switches with duplicate master switches on the buggy platform are not shown in Figure 4 as it is not fundamental to the main circuit. These can however be added without any difficulty or complication of the main control circuit.

The modern trend, even for the ingot buggy control in steel mills is to provide variable potential control with Ward-Leonard system and rotating regulators. Such a system however becomes rather costly and unless special reasons exist, the first costs of such a system is difficult to be justified.

The paper describes a simple system of constant potential control which requires no more control crossbars than are provided in any of the standard systems, and permits a smooth and selective operation with a constant potential rheostatic control system with minimum of control equipment which can be applied to any of the existing layouts when the ingot buggies are modernized and remote control adopted.

Calculations on Carbon Hearths

FOR BLAST FURNACES

By E. W. VOICE**
British Iron and Steel Research Association
England

. . . . this report is particularly interesting at this time since the Association of Iron and Steel Engineers has just started an experimental research project at Columbia University with the object of measuring the thermal distribution in some blast furnace hearth linings . . . .

▲ CARBON is used extensively for the hearth side wall and hearth floor construction in Britain, in the U.S.A. and Europe. There are many schools of thought for the optimum type of carbon, thickness of construction, and type and size of carbon block.

In general 2 ft 3 in. to 3 ft of carbon (water cooled) has proved very satisfactory for hearth wall construction and its use has given protection from hearth breakouts. Carbon hearths, however, have in general failed to survive undamaged, and when examined after a campaign, have been found to have disappeared from the centre or to have suffered considerable metal penetration below the original hearth level.

It is appreciated by most operators that with normal foundations there will be a higher temperature, say 4 ft below a carbon hearth, than 4 ft below a firebrick hearth, and that metal will penetrate to a greater depth in the carbon hearth. This is due to the increased thermal conductivity of carbon. Attempts have therefore been made to interlock the carbon bricks such that they are held down in spite of flotation forces should molten metal get under them.[1]* Let us consider the question of heat flow under a furnace hearth in order to estimate how far molten metal might be expected to penetrate and whether this depth can be reduced. One assumption is made and that is that joints, fissures or cracks will be present and will allow metal to penetrate if the temperature is above the melting point of the metal.

THERMAL CONDUCTIVITIES

One difficulty that has to be faced before calculations can be started, is to decide what values should be taken for the thermal conductivity of the materials involved.

The Research and Development Department of the United Steel Co. Ltd. quote values for Carblox of from 15.9 Btu per sq ft per hr per degree F per in. at 300 C to 27.2 at 1000 C. These figures have been plotted and extrapolated and used throughout.

For firebrick, values quoted vary from 4 to 6 Btu per sq ft per hr per degree F per in. at low temperatures rising to 10 at high temperatures. High and low values have been taken, but one unknown is the effect of joints on the thermal conductivity.

Concrete has been taken as having a thermal conductivity of 10 Btu per sq ft per hr per degree F per in., a figure obtained from the D.S.I.R.[2]

CALCULATIONS

On one recently-installed furnace, thermocouples were installed below the hearth, so let us consider this particular design.

Rough dimensions are 25 ft diam hearth, 5 ft thick carbon hearth walls (water cooled), and carbon hearth 4 ft 6 in. thick with stave coolers extending 3 ft below the bottom of the carbon. Below the carbon is 9 ft refractory brick and 9 ft cement fondu.

Mr. L. F. Daws, of the Mathematics Section of the British Iron and Steel Research Association, has applied "relaxation" methods to the problem of calculating the temperature distribution throughout the hearth. Figure 1 shows the results obtained assuming 30.1 Btu per sq ft per hr per degree F per in. for carbon at 1200 C and 4.1 Btu per sq ft per hr per degree F per in. for refractory brick and cement fondu. The figure of 4.1 is possibly too low and on later calculations higher values have been used. It is clear from Figure 1 that there is little temperature drop through the carbon hearth in the centre, and that molten metal would be expected to penetrate below the carbon bottom.

Many carbon hearths when blown out have shown a remarkable shape similarity between the blown out hearth lines and the 1180 C isothermal, suggesting that the carbon bricks survive at the periphery because they

*Numbers in parentheses refer to references in Bibliography at end of this article.

**Mr. Voice is now with the Central Research Establishment of the National Coal Board.

are below the temperature of molten metal, and those at the centre disappear because they are too hot to stay in situ as designed.

On the centre line of the hearth (Figure 1), three arrows indicate the position of thermocouples installed during construction. Figure 2 shows the temperatures attained at these points during the first six months after blowing in. The calculated final temperatures are 550 C, 280 C and 130 C and these can be compared with the actual temperatures. Clearly the furnace is not yet fully heated up, but if the agreement is thought to be reasonable, then it is reasonable to suppose that the calculated 1180 C isothermal is not seriously in error.

If 1600 C had been taken as the metal temperature instead of 1400 C, then all the temperatures would be raised by about 14 per cent and the 1180 C isothermal would be further down the hearth.

Mr. Daws has also calculated out the case of a 27 ft diam furnace with 3 ft carbon hearth walls, having a 6 ft 3 in. carbon hearth built on 8 ft firebrick above 16 ft concrete foundations. The stave cooling extends to the top of the concrete.

In order to reduce the amount of arithmetic he has assumed the temperature to be 0 C, 7 ft 6 in. below the top of the concrete. Conductivities assumed were 30.6 Btu per sq ft per hr per degree F per in. for carbon, 9.0 for hot firebrick, 7.25 for cool firebrick and 10 for concrete.

With 1400 C as the metal temperature, the centre line temperatures become 1110 C at the carbon-brick interface and 380 C at the concrete-brick interface. This temperature of 380 C may easily be 100 C too low since the temperature at 7 ft 6 in. below the concrete top must be higher than 0 C and may be considerably higher than this.

Concrete begins to lose its crushing strength when heated above about 250 C[3], and in order to avoid any damage to the concrete, air cooling pipes could be installed between the concrete and firebrick.

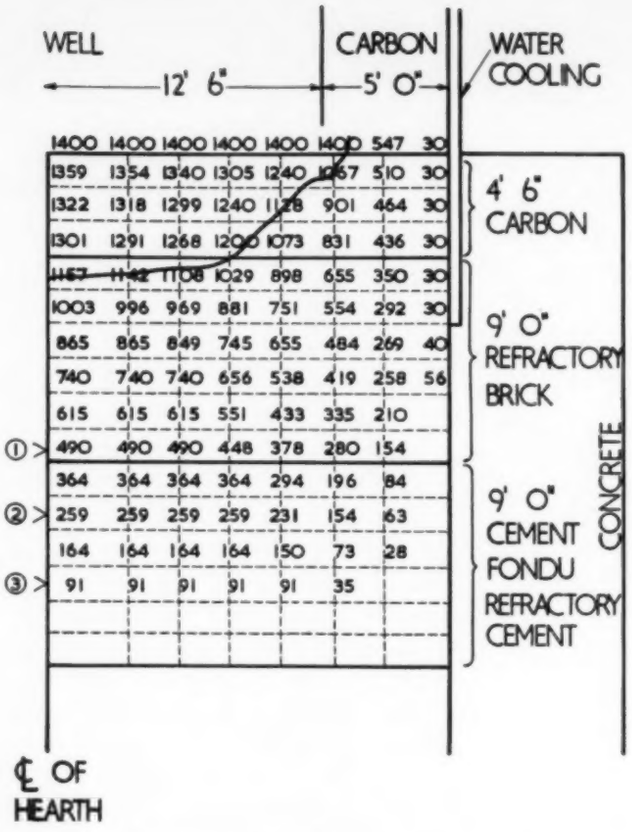


Figure 1 — The figures in this diagram represent calculated temperatures. The heavy line shows the 1180 C isothermal.

THERMAL CONTROL OF THE HEARTH BOTTOM

Let us decide that it is wrong to let the underside of the carbon become so hot, and that under-hearth cooling is installed. Assume a 6 ft carbon hearth of infinite diameter is installed on 6 ft firebrick which is built on the earth, and that cooling pipes are fitted at the earth level.

If the metal temperature is 1400 C and the underside of the carbon is to be limited to 1000 C, then the downward heat flow $= \dfrac{30 \times \dfrac{400}{6} \times 1.8}{12}$

= 300 Btu per sq ft per hr
(using a value of 30 Btu per sq ft per hr per degree F per in. for carbon at 1200 C.)

Assuming the firebrick conductivity = 6 Btu per sq ft per hr per degree F per in., then the cooling pipes would have to be at about −1000 C to maintain this heat flow. It is therefore abundantly clear that, to be effective, cooling must take place much nearer the carbon bottom.

If the cooling is at 2 ft below the carbon bottom, then with 300 Btu per sq ft per hr, the cooling pipes would be about 200 C and the underside of the carbon would be 1000 C.

The total heat flow for a 20 ft diam furnace, (ignoring side losses) would then be about 94,000 Btu per hr (29 kw), and could be removed by air cooling, using less than 1 hp fan power. This appears to be modest and practical.

AIR COOLING IMMEDIATELY BELOW THE CARBON

Let us suppose that 3 in. outside diameter air cooling pipes are laid parallel across the hearth floor at 1 ft centres, and these are floated off flat with refractory cement or carbon ramming, and the hearth proper consists of 5 ft 6 in. of carbon installed above the pipes.

In order to maintain 200-400 C as the maximum temperature for the base of the carbon, then it is necessary to extract approximately 900-1000 Btu per sq ft per hr, respectively, with a hearth metal temperature of 1600 C.

For an 18 ft diam furnace, the total air flow becomes something like 100,000 cu ft per hr and the pressure drop across the pipes in parallel is less than 2 in. water gage. The fan power is still only about 1 hp.

Provided, therefore, that the air cooling is somewhere between the base of the carbon and not lower than 2 ft of firebrick below the carbon, air cooling appears to be

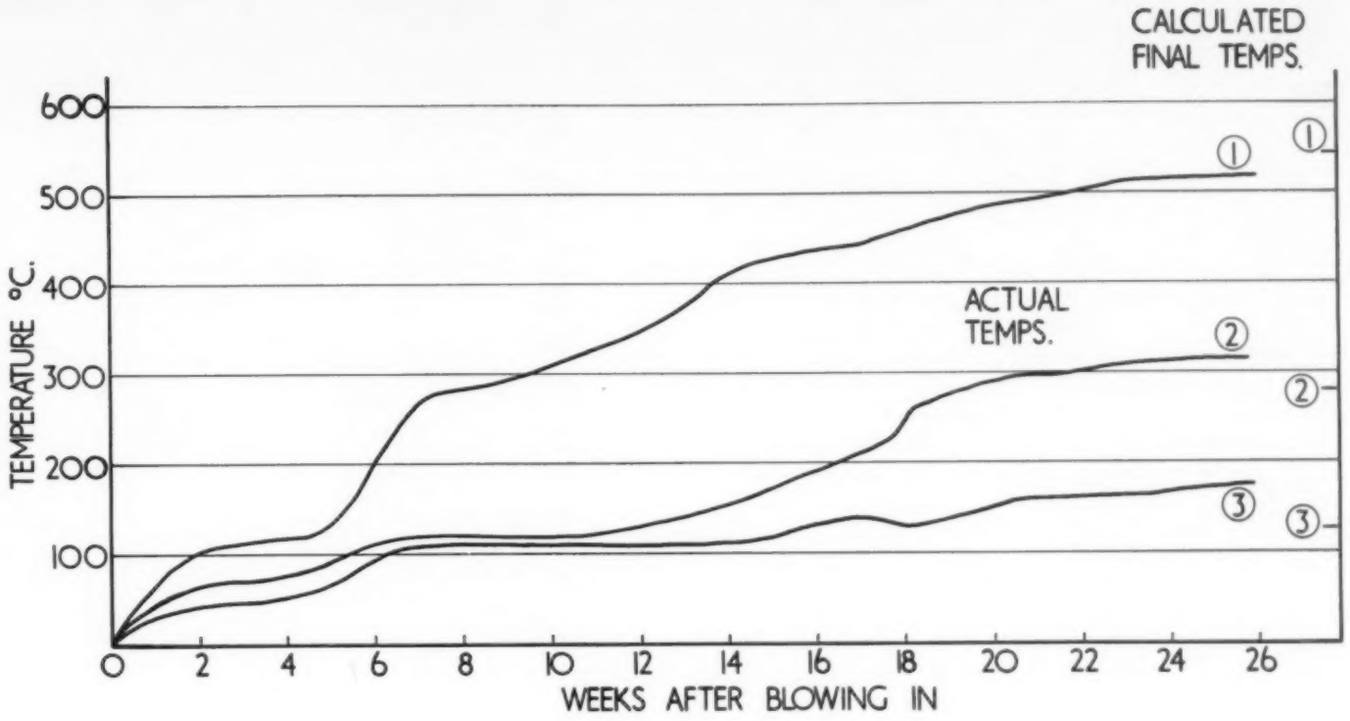


Figure 2 — Curves show actual and calculated temperatures below the hearth for the first six months after the furnace was blown in.

practical and should prevent molten metal penetrating under the carbon hearth.

Many people have mentioned the idea of underhearth cooling, and in view of the apparent ease with which it can be accomplished, serious consideration should be given to trying it out.

As a first trial, a furnace should be constructed of conventional design, i.e. with 6 ft carbon hearth backed off by 10 ft or so of firebrick and a good foundation. The air pipes could be installed, and, if for any reason they were disliked, they could be pressure filled by a carbon paste and the construction would then essentially revert to normal.

SHAPE OF BLOCKS

Suppose a 6 ft thick carbon hearth is air cooled at the base to 200 C and the metal is at 1600 C. Then molten metal might be expected to penetrate about 2 ft and if the top block is, say, 2 ft thick, then metal would get underneath and the flotation force would be roughly $2 \times 62.5 \times (8–1.5)$ lb per sq ft of the top surface area of block, i.e. 800 lb per sq ft. There is probably a slowly pulsating force on the top of the hearth due to the "dead man," and this pulsating force, together with an upthrust of 800 lb per sq ft might cause the block to wear at the corners and lift.

If the carbon hearth consisted of 6 ft columns set vertically and the base were air cooled, then again the metal would penetrate the vertical joints for 2 ft, but in this case there would be no vertical upthrust.

This construction has been suggested,[3] [4] and should be seriously considered together with air cooling. It would be better if the vertical surfaces could interlock and the suggested vertical hexagonal block with corrugated sides would be excellent. It may, however, prove too difficult to make. A vertical joint should not really matter, however, because the metal should penetrate so far and then freeze — provided the base is adequately cooled.

MODEL EXPERIMENTS

The calculations Mr. Daws has made are very tedious and time consuming, and the accuracy is limited to even less than the accuracy of the thermal conductivity data used. The Physics Department of B.I.S.R.A. has suggested that model experiments should be tried.

A 6 in. diam source of heated carbon can be arranged to operate at 1400-1600 C and models could be constructed, having this heater on the hearth floor. By scaling a 27 ft diam furnace to 6 in., the scale factor would be 54 to 1.

Provided the boundary conditions are copied, i.e. water cooling, etc., the model will then give the true temperature distribution throughout. The rate of heating up would be (54^2) times as fast, so one day's heating up would give the same temperature distribution as 8 years heating up on a full-scale furnace.

It would be an easy matter to see the effect of say 4 ft 6 in., or 7 ft 6 in. thick carbon hearths or the effect of running the stave coolers to different depths. The materials would be operating at their proper temperatures, so no assumptions would have to be made on thermal conductivities.

The model experiments using a thermal analogue have since been commenced by B.I.S.R.A. Additionally, an electrical analogue of a furnace hearth consist-

ing of a prepared network of resistances, has also been constructed. This will provide an electrical means of producing solutions of hearth design based on the "relaxation" technique, at a fraction of the time required for the full calculations.

CONCLUSIONS

1. On conventional furnace designs there appears to be a high probability that much of the carbon hearth will be submerged in molten metal, especially on large diameter furnaces.
2. Air cooling below a carbon hearth should prevent molten metal penetrating the hearth more than about 2 feet.
3. The power consumption and heat losses to do this would be negligible.
4. The cooling pipes would have to be within about 2 feet of the base of the carbon to be effective — preferably immediately below the carbon.
5. The first furnace trial should be arranged so that there is adequate firebrick below the cooling pipes, so that, should the pipes be abandoned, they can be filled under pressure with carbon paste or refractory cement, after which the furnace becomes essentially of conventional design. More air cooling pipes could be installed below the firebrick and used if and when the top pipes are abandoned.
6. On any furnace, if the concrete foundations are likely to become overheated, the top of the concrete should be air cooled for its own sake.
7. Even with an air cooled hearth, the top 2 ft or 3 ft of carbon hearth may be above the frozen metal line, so blocks less than this thickness would have a considerable upthrust. If the blocks were longer to prevent molten metal getting under, then there would be no up-thrust.
8. In order to preserve a carbon hearth for a furnace campaign, a first requirement would appear to be to exercise thermal control and preferably to use deep blocks so that their bottoms are held in frozen metal. If the carbon hearth does not dissolve in the pig iron, it should then last a long time.
9. Model experiments should be started to confirm the calculations used in this report. They would be useful for furnaces of conventional design, but would be of little value to test the efficiency of air cooling.
10. If on normal furnaces it is considered that 6 ft of carbon is satisfactory on an 18 ft furnace, then from similarity considerations 9 ft of carbon should be used on a 27 ft furnace for similar temperature distribution.

Acknowledgements — This paper was produced for the Blast Furnace Process Committee of the Iron Making Division of B.I.S.R.A. The Committee is thanked for permission to publish the paper.

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BUREAU TESTS SHOW TWO W. VA. COALS YIELD GOOD COKE

▲ COALS from two important beds in West Virginia, when properly blended, are suitable for making metallurgical coke, according to a Bureau of Mines bulletin released by Secretary of the Interior Oscar L. Chapman.

The bulletin is 55th in a series giving results of Bureau studies on the carbonizing properties of American coals. It describes tests made on samples of West Virginia coal from the Pittsburgh bed taken at the Jamison No. 9 mine in Marion County, and from the Upper Freeport bed taken at the Bull Run No. 1 mine in Preston County.

When coked alone at 900 C, the Pittsburgh bed sample yielded 67.1 per cent of coke, which is slightly below the average for 25 high-volatile A bituminous coals. Yields of tar and ammonium sulfate were above average, however. Blending this coal with 20 per cent Pocahontas No. 3 — a low-volatile blending coal — greatly improved the quality and increased the yield of coke, but decreased the yield of other products.

The coke yield from the Upper Freeport bed sample, a medium-volatile coal, was 73.7 per cent when coked alone at 900 C. This is below average for a medium-volatile coal, but the yields of tar and ammonium sulfate were above average. This coal gave strong, medium-grained coke when carbonized singly. Blending with 50, 70, and 80 per cent Pittsburgh coal lowered the coke yield, but raised the yields of other products. The 50-50 blend gave the strongest coke of the blends tested.

The bulletin also describes the sources and chemical properties of the coals, their agglutinating value, free-swelling index, plastic and expanding properties and amount and qualities of gas and chemical products. It includes tables, illustrations, and a complete list of Bureau of Mines bulletins on the carbonizing properties of American coals.

Bulletin 506, "Carbonizing Properties: West Virginia Coals from the Pittsburgh Bed, Jamison No. 9 Mine, Marion County, and Upper Freeport Bed, Bull Run No. 1 Mine, Preston County," was prepared by J. D. Davis, D. A. Reynolds, D. E. Wolfson, B. W. Naugle, chemists, and R. E. Brewer and G. W. Birge, chemical engineers. With the exception of Mr. Davis, now retired, all are stationed at the Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

Copies of Bulletin 506 may be obtained only from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., at 35 cents a copy. This bulletin is not for sale by the Bureau of Mines.

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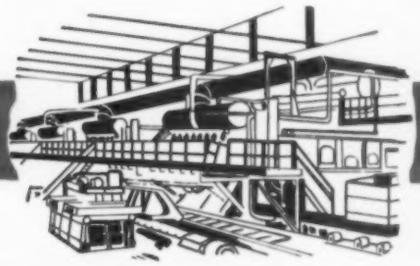

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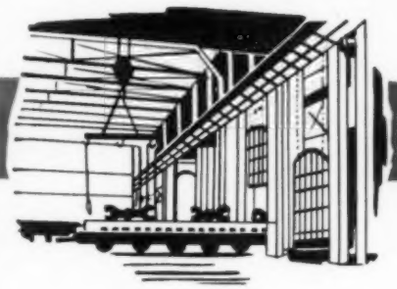

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RUST BUILDING **PITTSBURGH, PA.**

"STARTING LOAD ON OUR 40 H. P. CRUSHER MOTOR CAUSED 400 AMP. ORDINARY FUSES TO BLOW . . . BUT NOW 125 AMP. FUSETRON FUSES LET MOTOR START AND GIVE BURNOUT PROTECTION TOO."

Mr. Meeka explains . . .

"We have a crusher driven by a 40 h.p. 250 volt motor. The starting load on this motor is often quite heavy and gave us no end of trouble by causing the 400 ampere fuses protecting the circuit to blow.

"Some months ago, after checking the actual running current of the motor with an ammeter, we decided to see if FUSETRON dual-element Fuses could live up to their claims.

"The ammeter reading indicated that 125 ampere FUSETRON Fuses should be used to give motor-running protection. So, we installed this size.

"Were we surprised—they not only hold the starting current of the crusher motor—but we have the satisfaction of knowing the motor also has burnout protection to back up the overload relays in case they should ever fail.

"Not once since we installed FUSETRON Fuses have we lost a moment's production due to a fuse blowing needlessly."

ED MEEKA
Supt., ROBINSON BRICK & TILE CO.
Denver, Colorado

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

"FUSETRON FUSES NOT ONLY ELIMINATE USELESS SHUTDOWNS - THEY GIVE YOU 10 POINT PROTECTION."

1 Protect against short-circuits.*

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating—lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels

10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

DON'T RISK LOSSES

One **needless** shutdown . . .
One **lost** motor . . .
One **destroyed** switch or panel
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

MAIL THE COUPON NOW for complete information about the All-Purpose Protection of FUSETRON Dual-Element FUSES.

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me complete facts about FUSETRON dual-element Fuses.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City & Zone*_____ *State*_____ 552

On the firing line at "UNION"

Among the most urgent necessities of our national security program is steel . . . cast and fabricated for combat and used in a thousand other ways. Men at "Union" work around the clock to supply material and equipment so urgently needed by our armed forces . . . for fighting, for protection, for transport, for the many other functions of the nation's preparedness program.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

Specify **BOILER FEED PUMPS** by **Pacific**

for small and medium sized boiler plants

to insure

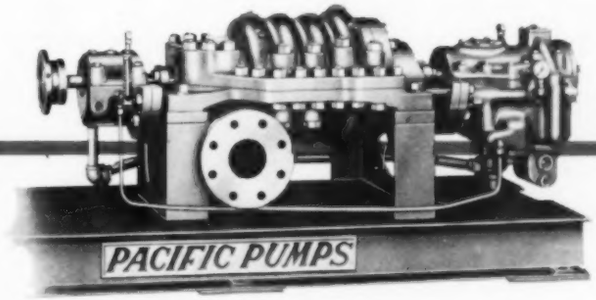
RELIABILITY... DURABILITY...
RESISTANCE TO CORROSION-EROSION

DEPENDABLE PERFORMANCE AND THE HIGHEST FACTOR OF AVAILABILITY AT ALL TIMES

THE Pacific

MULTI STAGE TYPE JBF

Capacities To — 1000 GPM
Discharge Pressures To — 1000 psi
Electric Motor Drive To 3600 RPM
Steam Turbine Drive To 5000 RPM



THE Pacific

SINGLE STAGE-UNITIZED STEAM TURBOPUMP

Capacities To — 500 GPM
Discharge Pressures to 1100 psi
STEAM To 900 psi Pressure — 850° F. TT
Exhaust Pressures To — 50 psi
Speeds To — 10,000 RPM.

PACIFIC *Precision Built* **PUMPS**

Pacific Pumps inc.
ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA
Export Office: Chanin Bldg., 122 E. 42nd St., New York
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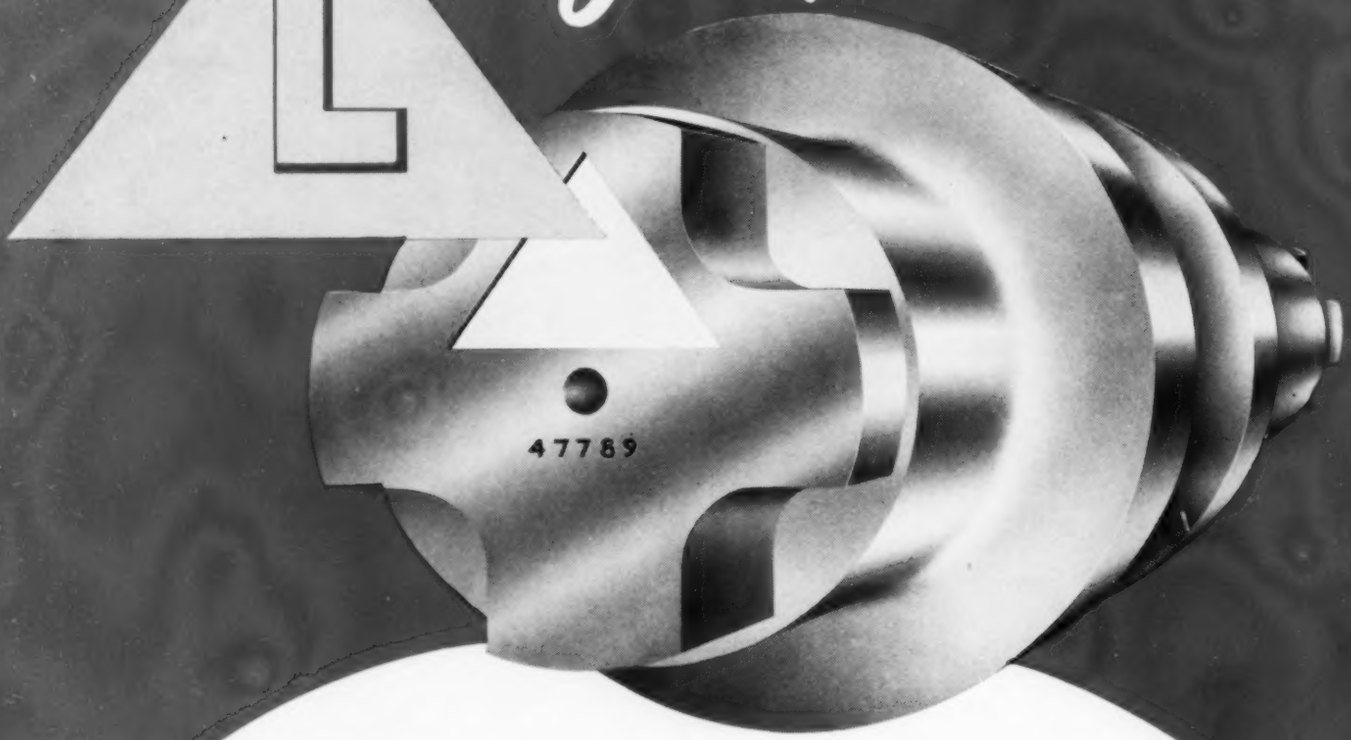
This marks the most efficient rolls

... for your mill



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LEWIS PLAIN CHILLED IRON ROLLS · LEWIS MOLYBDENUM CHILLED IRON ROLLS LEWIS "X" and LEWIS "XA" ROLLS · LEWIS SUPERIOR "X" ROLLS · LEWIS ATLAS and ATLAS "B" ROLLS · LEWIS SPECIAL PROCESS ROLLS · LEWIS AJAX DUPLEX ROLLS · LEWIS CLIMAX and AJAX ROLLS · LEWIS SPECIAL TUBE MILL ROLL

may we have the opportunity of studying your requirements and submitting our recommendations

MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

SOUTH AFRICA EXPANDS STEEL PRODUCTION

▲ African wealth, developed and undeveloped, is so strategically important, so varied in character, that it offers almost unlimited opportunities for trade and industrial expansion. The Union of South Africa, the most highly industrialized area of the continent, has taken the lead in this progress. The Union of South Africa, composed of four provinces (Cape Province, the Orange Free State, the Transvaal and Natal), is a high-lying country which rises from near the coast in a series of escarpments to a plateau often 6000 feet above sea level, and has a temperate, mild climate.

The South African Iron and Steel Industrial Corp., Limited (Iscor), the largest iron and steel producer in Africa, has played a spectacular role in the industrial development of South Africa in recent years. Its efforts, however, are not the first in the history of South Africa. A brief survey of the growth of iron and steel making in this area indicates that the history of iron and steel in South Africa dates back into antiquity. No one really knows who smelted the first iron ore, nor where — but there is a general belief that the continent of Africa was the birthplace of the art. Many native tribes knew it, but with the coming of the white man's methods, the old art died out.

In 1905, The Transvaal Iron and Steel Co. commenced erection of a second-hand steel plant bought from New Zealand. In 1911, the Dunswart Iron and Steelworks, a firm which is still in existence, began operations at Benoni. Seven years later, another firm which is still of importance, the Union Steel Corp., began production of steel at Vereeniging. The year 1917 saw greater activity in this line. The Pretoria Iron Mines, Limited, was formed in this year. Production began in a small blast furnace in 1918. Pig iron was even exported to northern neighbors.

In 1919, this company was formed into the South African Iron and Steel Corp., whose assets were later taken over by the present South African Iron and Steel Industrial Corp., Limited. This corporation was established in 1928, and is known as Iscor, for short.

In 1932 and 1935, the first two blast furnaces were constructed and erected in the plant at Pretoria by Ashmore, Benson and Pease, of Newcastle-on-Tyne, England, based on designs of Freyn Engineering Co., of Chicago. Operations were started by December of 1933. At the time of the outbreak of World War II, although it had only been in production for about five years, Iscor works had demonstrated that large scale production of iron and steel in South Africa was economically sound.

During the war, large quantities of its steel were supplied for war purposes. In total, Iscor manufactured special purpose steels to some 150 different specifications. This was accomplished in a works which had been designed and equipped primarily for the production of ordinary commercial steels.

In 1941, the corporation decided to proceed with plant extensions to increase the supplies of steel in the Union and to make the increased supplies available in the form which would be of greatest assistance for the war effort. The major projects involved were a third blast furnace, a blooming mill at Iscor works, Pretoria, and the installation of a new plant which was to be erected on a new site.

The new site, known as Vanderbijl Park, made provision not only for the

(*Please turn to page 138*)

Figure 1 — The 46-in. 2-high reversing slabbing-blooming mill rolls slabs up to 54 in. wide and billets down to 6 x 6 in.

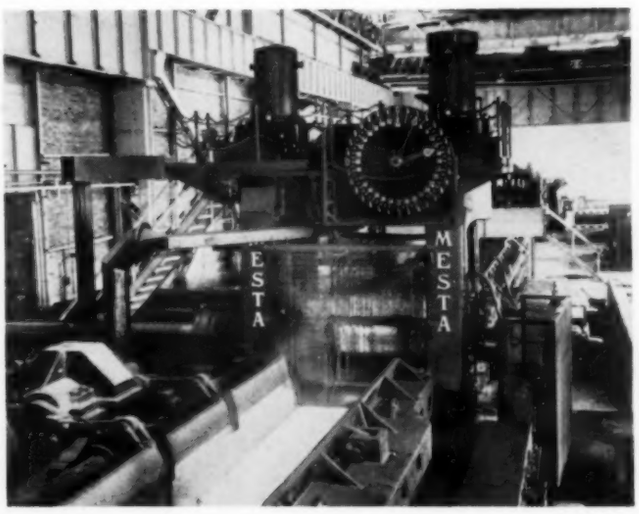
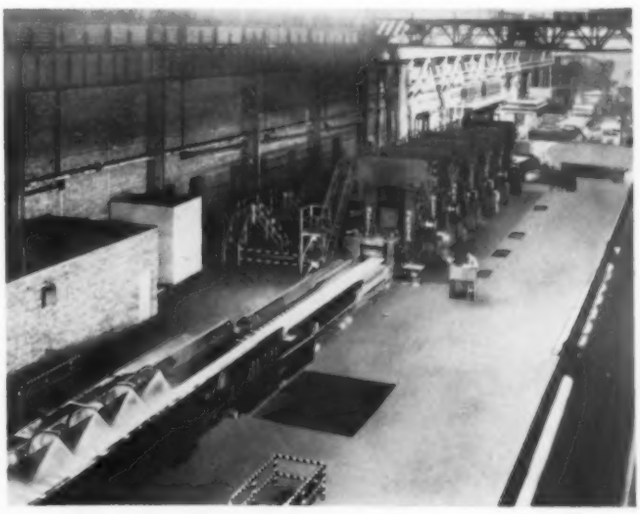


Figure 2 — The 56-in. continuous 4-high hot strip mill rolls steel up to 50 in. wide.



TNEMEC PRIMERS KILL RUST!

THE first step in preserving steel with paint is applying the prime coat. Its primary job is to prevent and kill rust action. TNEMEC Primers do just that, by creating a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

The second step is applying the finish coat that will provide protection against the specific exposure hazards involved.

WHAT IS YOUR EXPOSURE HAZARD?

Is it the humid, salt-air atmosphere of coastal areas? Is it the acid-laden atmosphere found in and around industrial plants, refineries, steel mills, the processing industries, etc? Is it submersion in sewage treating vats, in salt brine, or in fresh water tanks?

No matter what your problem is, there is a TNEMEC Finish Coat to solve it. And remember . . . you will always save many maintenance dollars by doing the job *right*.

Ask Any TNEMEC User
(TEE-NEE-MIK)

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this *TSP DRUM has saved $6501.50 on cables alone, and savings are continuing to mount

Final cable savings will not be known until this TSP Drum is completely worn out. Even after three times the life of previous competitive drums, there are no signs of wear, as shown in our "Industry Report"

Here's why—Ordinary drums have soft groove surfaces. They develop wear, corrugating and chafing. This means short cable life with resultant cable cost, downtime cost, etc.

TSP Drums are file hard. The hardened grooves are smooth and true and they stay that way for years. Any side swinging of loads has no effect on TSP drum grooves.

Due to TSP drums' hardened wear resistant surfaces, all chafing of cable is eliminated. Customer records show cable life extended three times with resultant large saving in cable costs.

INDUSTRY REPORTS

TSP Drum installed on 15 ton Morgan Crane at large Southern Ohio Steel Mill

SERVICE RECORD

TSP DRUM	COMPETITIVE DRUM
86 months service and still in operation with grooves smooth, showing no signs of wear.	26 months service and taken out of operation with grooves rough and worn with sharp edges not suitable for use.
25 days average cable life on a TSP drum.	8 days average cable life on competitive drum.

*TOOL STEEL PROCESS PRODUCTS . . . the products that carry an absolutely positive GUARANTEE to give a longer life in the same service than any other product.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

THE STANDARD OF QUALITY SINCE 1909 FOR GEARS • PINIONS • ROLLS • WHEELS AND OTHER HARDENED PRODUCTS

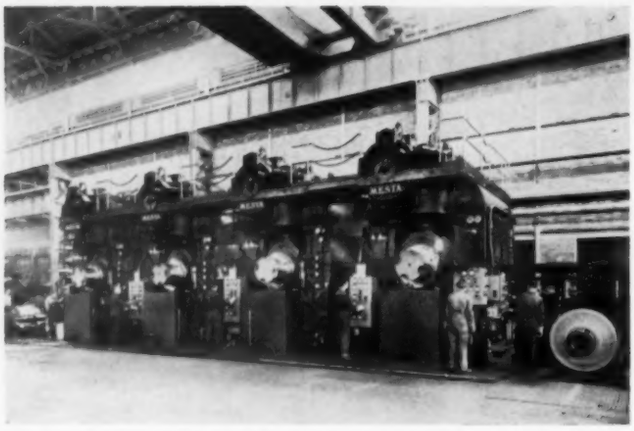


Figure 3 — The 56-in. 4-high tandem high speed cold mill.

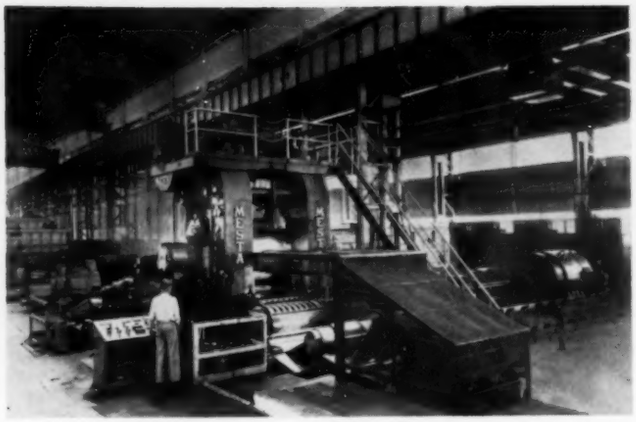


Figure 4 — The 56-in. 4-high single stand skin pass mill.

(*Continued from page 135*)

works, but also for a town. The initial steel works consists of two blast furnaces, coke ovens, by-product plant, and up-to-date open hearths.

The Mesta Machine Co. of Pittsburgh, Pa. was awarded the contract for steel rolling units for the completely integrated Vanderbijl Park works. At the beginning of World War II, they designed and built the 110-in. four-high reversing plate mill at Vanderbijl Park, which enabled the South African concern to produce the plate that was badly needed for the British naval program.

The Mesta Machine Co. was subsequently commissioned by Iscor to lay out and design the new plant, furnish or acquire mechanical, electrical and auxiliary equipment, and supervise the installation required for a slabbing-blooming mill, a continuous hot strip mill, and a cold reduction mill with auxiliaries.

The 46-in. two-high reversing slabbing-blooming mill and equipment (shown on Figure 1) is designed to roll from ingots, slabs up to 54 in. maximum width and billets down to 6 × 6 in. The maximum weight of the slab ingots is 30,000 lb.

The 56-in. continuous hot strip mill (shown on Figure 2) rolls steel up to 50 in. wide from suitable breakdowns produced on the 110 in. reversing plate mill.

A Mesta pickling line was constructed that is capable of pickling hot rolled steel strip 18 to 50 in. wide and up to 3/16 in. thick.

The 56-in. four-high four-stand tandem cold mill (shown on Figure 3) produces cold rolled strip steel from hot rolled pickled coils.

The equipment designed and built by Mesta Machine Co. will be capable of extension up to an ultimate ingot capacity of 1,000,000 tons per annum.

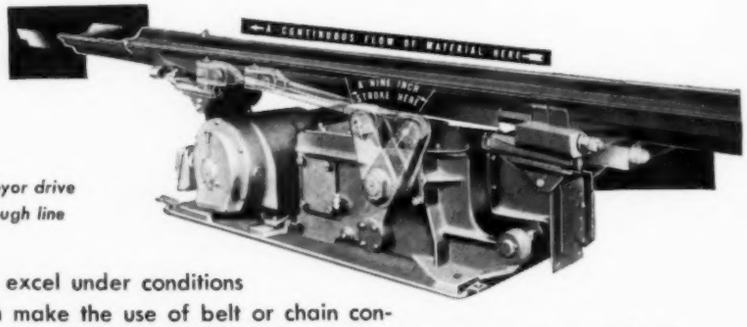
A large volume of galvanized sheets is used in South Africa, and this material forms a substantial portion of Iscor's production. To satisfy this demand, two Mesta continuous galvanizing lines (Sendzimir process) were installed; they are supplying this market with galvanized sheets made by the most modern methods.

Necessary electrolytic cleaning lines, skin pass mills (shown on Figure 4), annealing equipment, and tinning, shearing, and sorting equipment were installed. These installations gave South Africa one of the most modern and up-to-date steel plants in the world.

NEW! GOODMAN SHAKER CONVEYORS

offer a practical and economical method of moving hot and abrasive materials.

Whatever you want to move — coke, sinter, steel scrap, castings, silicon carbide, mill scale, dolomite, bauxite, or other hot, abrasive material — it will pay you to investigate Goodman's specially designed shaker conveyors.



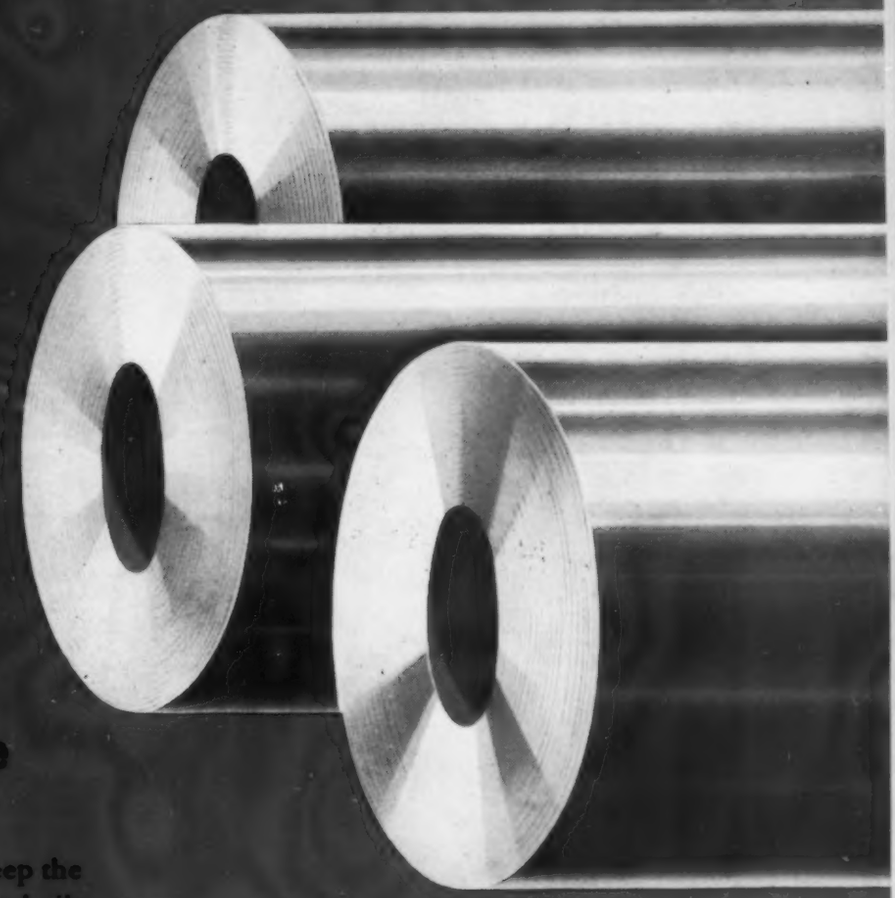
Shaker conveyor drive unit and trough line

They excel under conditions which make the use of belt or chain conveyors impractical. Small tonnages or large tonnages are moved with ease, for short or long distances — upgrade, downgrade, or on the level.

Every Goodman Shaker Conveyor installation is engineered to suit its specific application.

GOODMAN MANUFACTURING COMPANY
Industrial Manufacturing Division
Halsted Street at 48th **Chicago 9, Illinois**

by the hour...



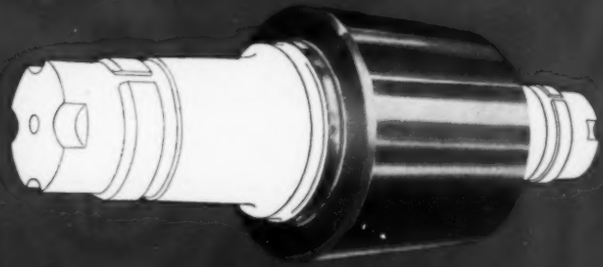
and by the ton

Heppenstall back-up roll Sleeves make good production sense

Heppenstall Sleeves for Back-Up Rolls keep the mill line running longer because they're built to last. They mean less down-time—increased productivity—lower overall costs. Their records of performance make good production sense. They show increases in productivity of from 61% to 128% in terms of roll service, which are typical of the benefits in time and cost savings—increases in production.

And, there's plenty of "reason why" Heppenstall Sleeves provide this exceptional service. Each sleeve is forged from Heppenstall's own alloy steel and "custom-built" . . . normalized, annealed, heat treated, and tempered to exact specifications. The results: correct hardness . . . maximum density . . . perfect fit . . . durable surfaces . . . resistance to cracking and spalling in high speed service.

For complete information and technical assistance, call Heppenstall Company, Pittsburgh 1, Pa. Sales offices in principal cities.



Heppenstall

—the most dependable name in forgings

"Trabon lubrication has saved millions of dollars for industry"

● No machine can operate efficiently without proper lubrication. Trabon Lubricating Systems —which handle both oil and grease on machines of any size—have proved their ability to do a good job for industry during 21 years of service.

The Trabon lubricating system can be concealed on any machine . . . it can be buried in dust, dirt, water or grime . . . and withstand the heat and vibration on the toughest operation.

Trabon has the only completely enclosed measuring valve that notifies the operator if trouble develops . . . each bearing gets the right amount of clean lubricant at the right time. Longer bearing life, less down time for costly repairs, and more production are the results you get from Trabon lubrication.

TRABON ENGINEERING CORP.
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Trabon

OIL AND GREASE SYSTEMS

Date-line Diary...

June 2

▲ The Labor Department's Bureau of Employment Security stated that unemployment covered by state unemployment compensation reached its lowest level for the year, due to seasonal improvements in construction and gains in some lines of durable goods manufacturing.

▲ The operating rate of the steel industry for the week beginning June 2 was scheduled to be 101.6 per cent of capacity which was prior to the Supreme Court's ruling on the seizure of the steel industry. This is equivalent to 2,111,000 tons of steel ingots and castings compared to actual production of 2,091,000 tons one week ago.

June 3

▲ Steel plants were turned back to their owners when government seizure of the steel industry was voided by the Supreme Court. The top tribunal's six to three decision upheld Judge Pine's finding that seizure of the steel properties was unconstitutional. Some 650,000 CIO steelworkers began leaving their jobs and started to set up picket lines.

▲ Steel shipments were banned by the government from warehouses to manufacturers of civilian products in order to conserve steel for defense needs.

▲ Price of zinc was reduced 2¢ a lb to 17½¢. A falling off in demand for zinc in foreign countries is responsible for reduction.

June 4

▲ On May 10 there were 61,176,000 job holders, 1,000,000 above April levels, as employment continued to climb.

▲ Commerce and Labor Departments reported construction outlays in May rose to $2,700,000,000, a new high for the month.

▲ General Services Administration announced the base price for manganese ore was raised to $2.30 for a long ton unit, to be delivered to the government's purchase depot at Deming, N. M.

June 5

▲ Jones & Laughlin Steel Corp. stated it will not reopen its three bessemer furnaces at the South Side Pittsburgh works, regardless of the outcome of steel strike, as furnaces were slated for removal under modernization program.

▲ Steel wage negotiations resumed in Washington today as officials of the six strike-bound companies and the CIO Steelworkers were summoned by Presidential Assistant John R. Steelman to a bargaining session.

▲ United States Steel Corp. has taken options on 5400 acres of western Ontario farm land in order to start exploratory drilling for iron ore. Jones & Laughlin Steel Corp. has started drilling at Port Hope, and Bethlehem Steel Corp. is drilling for iron ore at Marmora on a $10,000,000 project.

June 6

▲ Zinc was reduced an additional 1½¢ to 16¢ a lb in East St. Louis. Further reduction was partly due to deferment of zinc orders by strike-bound steel mills.

▲ According to the AISI, average weekly hours, hourly earnings and total payroll were reduced from recent averages in April as a result of the steel wage controversy. Wage earners averaged 37.7 hours a week, and payments averaged $1.938 an hour. Estimated payroll of the entire industry in April was $225,568,000 or $17,000,000 less than March.

June 9

▲ The operating rate of the steel industry, which was 100.7 per cent of capacity for the week starting May 26, declined to 38.7 per cent for the week of June 2 and is scheduled to be 12.5 per cent of capacity for the week beginning June 9. The operating rate scheduled for this week is equivalent to 259,000 tons of ingots and castings for the entire industry against 804,000 tons produced for the week starting June 2.

June 10

▲ American Railway Car Institute announced May deliveries of new domestic freight cars totaled 6857 compared with 9774 in May. Orders for new freight cars totaled 2502, and the backlog of cars on order as of June 1 was 103,910.

▲ U. S. exports in April were valued at $1,331,000,000, off 6 per cent from March. Imports in April totaled $931,000,000, which was a 3 per cent drop from March.

▲ According to the Aluminum Association, production of primary aluminum in April totaled 153,759,727 lb. Aluminum sheet and plate shipped in April totaled 84,209,424 lb.

June 11

▲ A new production record was set in May when Kaiser Steel Corp.'s Fontana plant produced 122,036 tons of steel ingots compared with its previous record mark of 121,463 tons in October 1951.

▲ The Senate rejected two legislative proposals to give the Government seizure authority in national emergency strikes, but adopted a resolution calling upon President Truman to invoke the Taft-Hartley law in the steel dispute.

June 12

▲ Galvanized sheet prices of U. S. Steel Co. will be reduced about $1.75 to $8.75 a ton depending on gage because of the reduction in zinc prices.

▲ Commerce Department reported personal income in the first four months of this year ran at an annual rate of approximately $259,000,000,000, which was a 5 per cent increase over the same period in 1951. The $258,900,000,000 in April was slightly above that of March.

▲ The RFC approved an $8,574,799 loan to Lone Star Steel Co. to defray expansion costs.

June 13

▲ Ford Motor Co. announced that it will begin closing its plants across the nation in two weeks unless steel strike is settled. Car and truck makers were beginning to lay the groundwork to revive the conversion steel market.

June 16

▲ Shipping operations came to a standstill for lake iron ore carriers due to the steel strike. In the week ending June 2, lake carriers moved 3,125,969 tons of iron ore, but in the week ending June 9, tonnage moved dropped to 1,565,739 tons. Steel plants stock of iron ore at furnaces on May 1 totaled 19,591,854 tons.

June 17

▲ Algoma Steel Corp., Ltd. at its Saulte Ste. Marie, Ont. works has put into operation three new batteries of soaking pits, which were built by Rust Furnace Co.

▲Jones & Laughlin Steel Corp. asked the courts for an injunction against "Unlawful Picketing" at its two plants in Pittsburgh, stating that the supervisors and plant executives confined to the Pittsburgh works were inadequate to cope with the maintenance problems. The company also asked the court to limit the number of pickets at any entrance to not more than six.

▲ The House passed and sent a bill to President Truman extending federal controls over rubber from June 30, 1952 to March 31, 1954.

June 18

▲ The RFC has agreed to a $31,050,000 loan at 5 per cent to Detroit Steel Corp. Private financial interests will supplement the government sum by a minimum of $13,950,000. The $45,000,000 loan will be used to help the company expand its steelmaking facilities, which include a hot-rolled sheet and strip mill, a cold rolled sheet and strip mill, a 1400-ton blast furnace, a blooming mill with soaking pit and four 250-ton basic open-hearth furnaces. The program is designed to step up ingot production to 1,290,000 tons annually from the present 660,000 tons.

▲ Schuman coal and steel pool plan to unite Western Europe's coal and steel production was cleared by Italian Parliament.

June 19

▲ NPA boosted the amounts of copper and aluminum which manufacturers may buy in the third quarter without federal authorization. This includes an additional 100,000,000 lb of copper. This action frees 25,000 copper and aluminum consuming firms from filing applications with the NPA.

▲ Price of zinc dropped 1¢ a lb to 15¢ in East St. Louis.

▲ United Mine Workers offered a $10,000,000 loan to striking CIO Steelworkers to help win their fight against the steel industry.

June 20

▲ Phil Murray, president of the CIO Steelworkers, has given his O.K. for a number of companies to turn out steel for defense only, but will not permit United States Steel Corp. to go into limited production during the present strike.

▲ The National Safety Council reported that the accident frequency rate for employees in all the industries was 9.06 per 1,000,000 man hours in 1951, a reduction of 3 per cent from the year before. The accident severity rate for all industry was 0.97 days lost per 1000 man hours, an increase of 3 per cent from 1950. The frequency rate for steel was 4.50 per 1,000,000 man hours and the severity rate for steel was 1.16 days lost per 1000 man hours.

June 21

▲ Armco Steel Corp. negotiated new wage agreements with independent bargaining agents at five plants of Armco Steel located at Middletown, Hamilton, Zanesville and Butler. New contracts give an average wage increase of 16¢ an hr plus other benefits. No union shop is included.

June 23

▲ OPS suspended price controls on a number of products and services selling below ceiling prices.

▲ Tatsunosuke Takasaki, a Japanese industrialist, is trying to organize the India Development Company to build two 1200-ton blast furnaces in India to supply Japanese steel plants.

June 24

▲ United States Steel Co. received a quick tax write-off certificate on 65 per cent of $99,000,000 worth of iron ore transportation facilities which the corporation plans to install at its Ciudad Bolivar ore deposits in Venezuela.

▲ Lead prices reversed their decline and moved up ½¢ to 15½¢ a lb.

▲ Weirton Steel Co. signed a new contract today with their independent steelworkers union giving a general average wage increase of 16¢ per hr, and other benefits. The union shop was not an issue and was not included. It was estimated that the total cost of the increase is about $10.00 per ton of steel.

June 25

▲ The CIO Steelworkers turned down an offer by Granite City Steel Co. of a wage boost averaging 16¢ an hr plus fringe benefits. Union shop was not an issue since Granite City has been operating under a union shop clause. Union chairman stated the company's offer was not fully up to government WSB's recommendations.

▲ Steel scrap was selling in Buffalo at prices of $5.00 to $8.00 a ton below the government ceiling.

▲ American Institute of Steel Construction reports May shipments of fabricated structural steel of 241,743 tons, an increase of 5 per cent over the previous month. Bookings for May totaled 210,118 tons. Total backlog as of May 31 totaled 2,263,443 compared with 2,771,264 one year ago.

June 26

▲ Wheeling Steel Corp. and Pittsburgh Consolidation Coal Corp. are forming a jointly owned subsidiary, Harmar Coal Co., to operate two mines owned by Wheeling and reserves leased from Pittsburgh Consolidation Coal.

▲ Weirton Steel Co. announced compensation of all salaried employees is being adjusted back to April 1. Employees earning up to $25,000 a year will receive an 8 per cent increase and employees earning more will receive a 4 per cent increase.

June 27

▲ RFC announced the price of synthetic rubber is being maintained at 23¢ a lb.

▲Pittsburgh Steel Co. signed an agreement with the CIO Steelworkers. It is the first leading steel producer to sign. Workers were granted an increase of 12½¢ an hr plus fringe benefits and a modified version of the union shop.

▲ The NPA eliminated the last control on zinc and suspended limitations on inventories.

June 29

▲ The F. W. Dodge Corp. announced that construction contract awards in May for the thirty-seven states east of the Rockies totaled $1,563,660,000 or 2 per cent less than April.

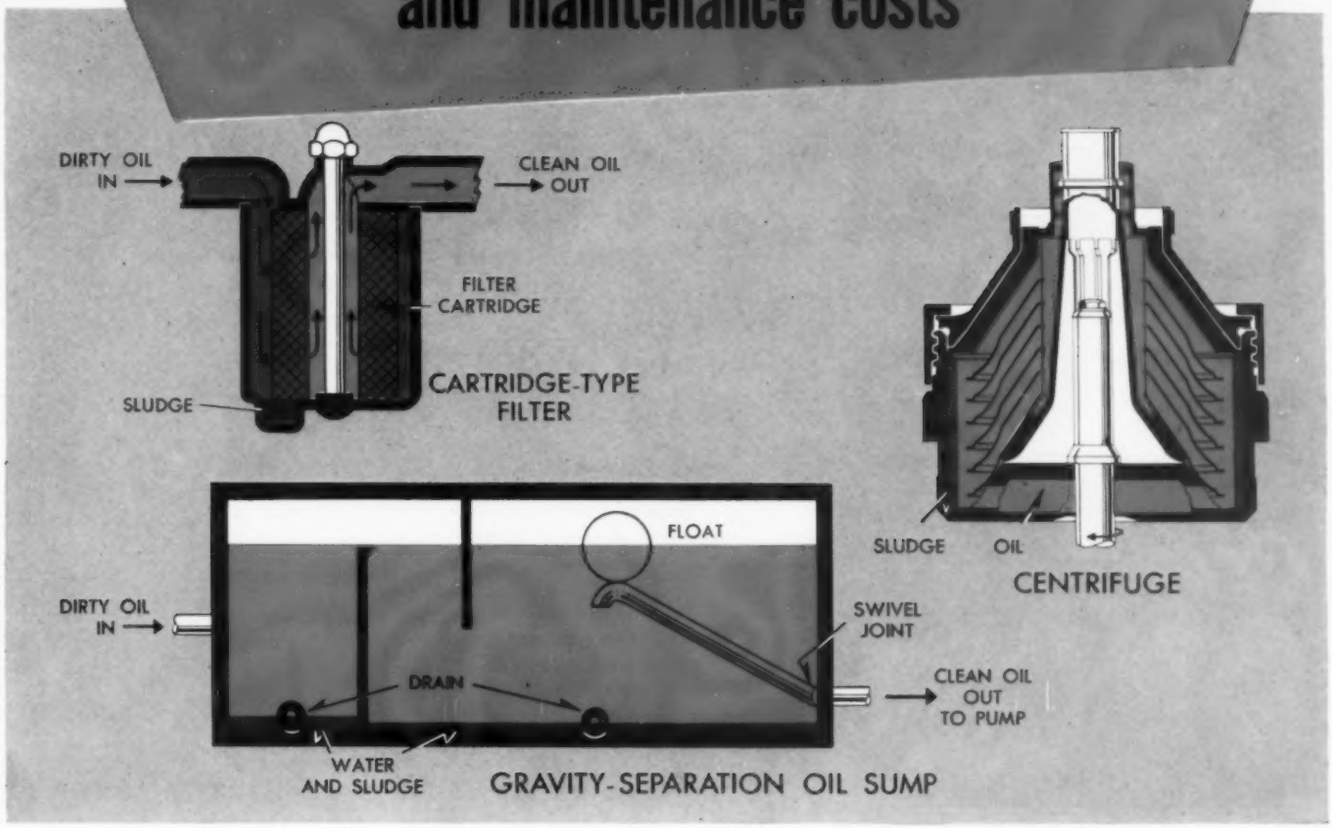
June 30

▲ Weirton Steel Co. asked the government to authorize steel price increases averaging $5.50 a ton to cover wage boosts recently granted employees.

▲ The operating rate for the steel industry for the week beginning June 30 is scheduled at 12.3 per cent of capacity based on reports from companies having 93 per cent of the industry's capacity. This rate is equivalent to 256,000 tons of ingots and castings. It was announced by the AISI for the week beginning June 23, the rate was 11.8 per cent of capacity equivalent to 246,000 tons. The AISI further estimated the total steel loss up to the week starting June 30 was about 9,098,000 tons due to strikes this year. Total loss of steel production for all major strikes since World War II has risen to more than 38,038,000 tons.

NUMBER 2 OF A SERIES

How Gulf Periodic Consultation Service helps rolling mills cut lubrication and maintenance costs



Expert counsel provided on filtering and purification of oil

You'll find that Gulf Sales and Staff Engineers do more than simply recommend the proper oils and greases for equipment in your mill. They offer practical help on every phase of lubrication.

For example, they are prepared to make helpful suggestions on questions like these about filtering and purifying lubricating oils:

1. Suitability of various types of filters and systems for various contaminants and operating conditions.
2. Their effect on different lubricating oils.
3. Operation of circulating oil systems.
4. The removal of water from lubricating oils.

This is just one phase of the plan known as Gulf Periodic Consultation Service. For additional information, call in a Gulf Sales Engineer today or send the coupon below.

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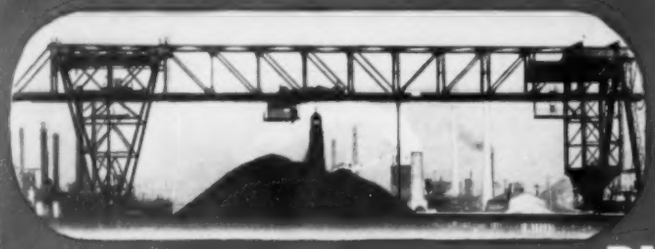
CLARK DC MAGNETIC CRANE CONTROL



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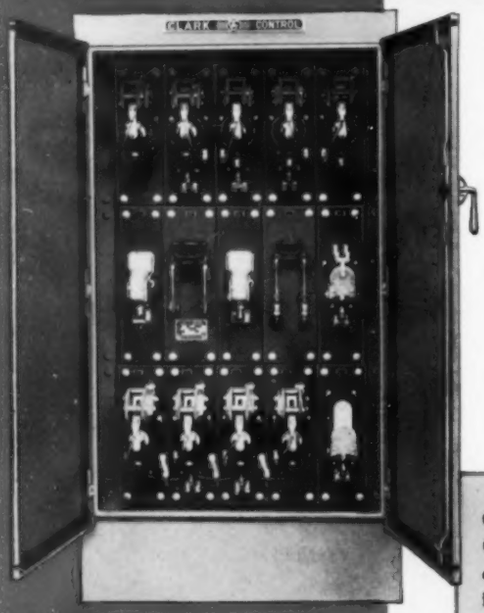
VARI-TIME PRINCIPLE OF ACCELERATION

for greater

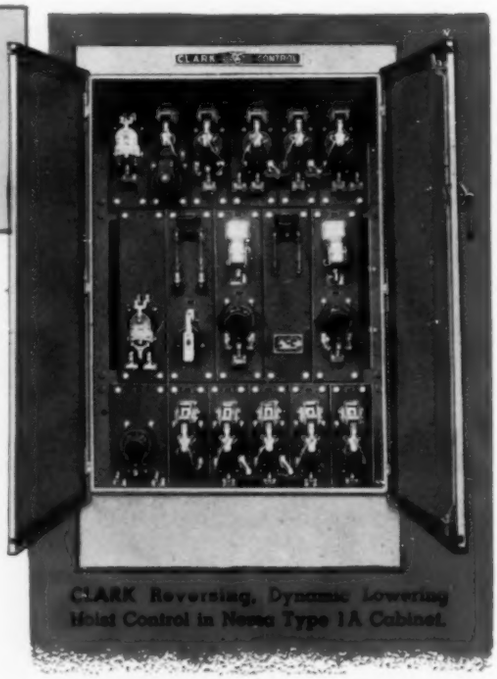
RUGGEDNESS and SIMPLICITY



CLARK Reversing—Plugging Bridge Control in Nema Type 1A Cabinet.

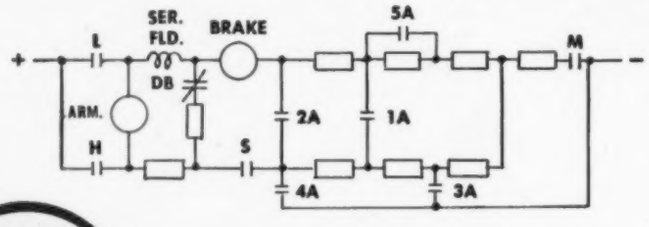
Through the use of the CLARK exclusive VARI-TIME principle, the need for 3 separate timing relays is eliminated in CLARK Reversing—Plugging Bridge and Trolley Controls. Moreover, a single, simple relay of rugged, heavy, mill duty design and construction—gives fast, accurate reversing—plugging. The result is dependable, smooth and efficient operation—with greater protection for crane motors and mechanical components, and with minimum maintenance and down time.

CLARK DC MAGNETIC CRANE CONTROL is available with standard panels, as illustrated, for traveling overhead cranes, also with specially engineered panels for large coal bridges, ore bridges, etc.



CLARK Reversing, Dynamic Lowering Hoist Control in Nema Type 1A Cabinet.

CLARK HOIST CONTROLS provide smooth acceleration and safe dynamic lowering. Together with CLARK Bridge and Trolley controls, they form an unbeatable combination for outstanding crane performance. Note simplicity of hoist circuit in this power diagram for Bulletin 9135 Form M. Hoist Control.



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Industry News...

PROCESS AND PATENT RIGHTS COVERING ELLIOTT OXYGEN SYSTEM ARE SOLD

▲ Purchase of all process and patent rights covering the Elliott oxygen system for the production of tonnage oxygen and high purity nitrogen, and the availability of complete plants of this type on a turn-key contract basis was announced here today by H. K. Ferguson Co.

Dr. Irving Roberts, who participated in development of the Elliott system, has been retained by the Ferguson Co. to offer technical assistance and consultation to companies desiring to purchase the oxygen plants.

The Elliott process is a new system, differing markedly in some respects from systems developed abroad and now offered in this country. Ferguson engineers have cited the following outstanding advantages:

The system is mechanically simplified, operates at reduced loads without sacrifice in efficiency, and is completely immune to possible dangers of acetylene explosions of existing processes; controls are completely automatic and will automatically adjust the system to any oxygen demand; periodic shut-downs for removal of accumulated deposits of water and carbon dioxide are avoided — a particularly desirable feature for processes which must be kept "on stream" at all times; recovery of oxygen from air charged to the system is over 97 per cent; liquid nitrogen is readily available from the system; and gaseous or liquid nitrogen purity is guaranteed at 99.8%.

Oxygen on a tonnage basis is a new tool for the steel, chemical and process industries. It is expected that the use of oxygen will greatly increase the output and economy of open hearth furnaces, blast furnaces, Bessemer converters and electric furnaces. Use of oxygen combined with natural gases opens up a new source of supply of gasoline, fuel oil and chemicals. Coal can also be used instead of natural gas in the production of gasoline, fuel oil and other products. Even substitute natural gas can be made from coal at the mine by the gasification of coal through the use of oxygen. Other possible uses include the smelting of sulphur-bearing ores such as nickel, copper zinc, and lead. The use of oxygen in the chemical industries offers unlimited possibilities.

Individual commercial installations which will produce more than 25,000,000 cu ft (1000 tons) of oxygen per day are envisioned by the Ferguson Co.

The Elliott oxygen system is an outgrowth of work by the Elliott Co. during the last war in connection with the oxygen program conducted for the government by the National Defense Research Council. Elliott's principal contribution was a successful design for the first low-temperature, turbo-expander produced in this country.

Upon completion of this project, the Elliott Co. embarked on a 3-year development program of its own which culminated in the design and construction of a pilot plant of a completely integrated oxygen system, using equipment of special design. This process is now the property of the Ferguson Co.

U. S. STEEL DEVELOPS "MINE-IN-THE-SKY"

▲ United States Steel's development on a West Virginia mountainside of a completely mechanized new coal mine that eventually will produce 10,000 tons a day has helped strengthen McDowell County's claim to the coal-producing championship of the world.

Gary No. 14 Mine is the company's newest "mine in the sky." Located 2160 ft above sea level at Munson, seven miles south of Gary, it is the sixth major operation by U. S. Steel's coal division in the district. Other local mines of the company are located at Gary, Ream, Filbert, and two at Wilcoe.

The mine is now producing 4000 tons of high-grade metallurgical coal

Here's a new use for the ski hoist, that chain-belt seating device that makes going up easy for skiers. This is the first known application of the idea at a coal mine. Installed at U. S. Steel's new Gary No. 14 Mine near Gary, W. Va., the hoist carries the miners back and forth between upper and lower levels. Shown are miners, at the end of a shift, riding from the lower portal to the bath house above.

NEW CATALOG No. 852

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As easy to read as any picture book . . . with few words, but almost a hundred installation pictures of conveyers and conveying systems in action . . . handling materials efficiently for some twenty-five classes of American and Canadian industry.

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PORT HOPE, ONTARIO

a day, and the potential output of 10,000 tons a day will be attained, officials predict, after all of the major inside development work is completed. All coal mined from the new operation is shipped direct to U. S. Steel mills in Indiana, Illinois, and Ohio.

The surface development work at the mine has resulted in one of the most extensive mountainside face-lifting jobs ever seen in West Virginia mining history. The entire side of a towering, tree-covered mountain has changed appearance, and the location is now a bee-hive of mining activity.

The moving of more than a million and one-half cubic yards of earth and rock was a gigantic task undertaken at the outset of the development work, to make the site accessible by auto. This required cutting through timber along the mountainside and changing the terrain for a distance of about three miles.

Modern mechanical coal mining equipment is in use throughout the mine, including combination drilling and cutting machines, and loaders that scoop up the "black diamonds" at a fast clip.

More than 27 miles of track already have been laid at Gary No. 14 Mine, including 20 miles in the underground workings.

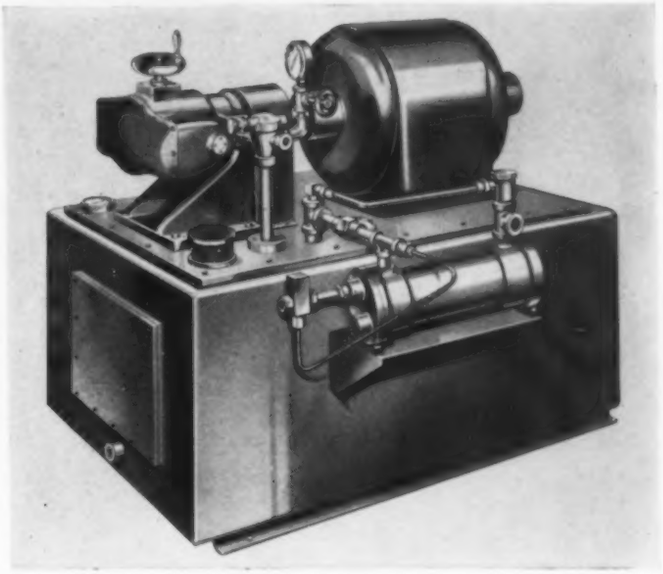
The coal is being mined at two levels of the famed Pocahontas seam. Each level is a separate operation, and the coal is delivered at the surface through separate portals of the No. 3 and No. 4 seams. On rotary dumps at the tipple, the mine cars are dumped onto a 577-foot conveyor belt which carries the coal to waiting railroad cars for shipment to U. S. Steel's large washing and blending plant at nearby Alpheus. There, it is processed and readied for shipment to the company's steelmaking plants.

The mine is not only among the newest in McDowell County, but is also among the most modern in West Virginia.

Perhaps one of the most unique pieces of equipment employed by coal miners anywhere can be found at this new U. S. Steel operation. This is a ski hoist, which carries the miners up and down a 70-ft cliff between levels of the Pocahontas seam. The ski hoist has attracted the attention of many visitors to the mine.

Of the four large new surface buildings at the mine, the bathhouse is the most important as far as the miners

MORE MACHINE MANUFACTURERS INSTALL MARVEL SYNCLINAL FILTERS AS ORIGINAL EQUIPMENT

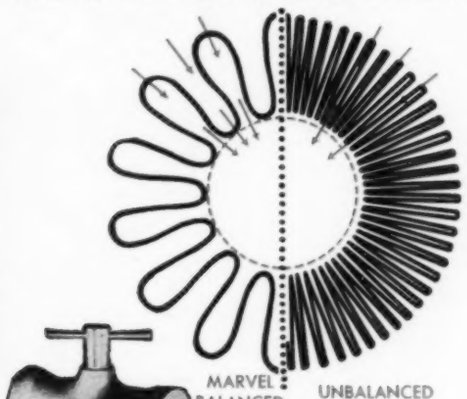


Large series hydraulic pumping unit manufactured by The Denison Engineering Co., Columbus, Ohio to recommendations of the Joint Industry Conference. These pumping units are equipped with Marvel Synclinal Filters.

They Know That ONLY ACTIVE FILTER AREA COUNTS!

It isn't the total amount of filtering mesh that may be squeezed into a filter unit but the amount of ACTIVE, WORKING filter mesh that counts. Surplus mesh not only fails to filter but obstructs the passage and slows the flow. A too crowded unit does not have adequate space for storage of accumulated foreign matter — tightly packed pleats of mesh can soon become clogged with filtered out material. Marvel Synclinal Filters are balanced to provide maximum mesh area for all the liquid which can pass through the space and allow necessary room for filtered out material. That is why they excel in maintaining efficiency through longer periods between cleanings. Not only is the frequency of cleaning reduced but disassembly, cleaning and reassembly is so simple that ordinary workmen can do it quickly.

SUMP TYPE (Cutaway)



LINE TYPE (Cutaway)

FACTS — NOT CLAIMS

"Campaign promise" claims mean little to engineers. They want the record, measurable facts. That is why over

270 MANUFACTURERS have picked Marvel Synclinal Filters AS THEIR O.E.M. CHOICE

Meets J. I. C. Standards

Sump and line models available in capacities from 5 to 100 g.p.m. Mesh sizes from 30 to 200. All models operate in any position. Line models may be serviced without disturbing pipe connections. For efficient filtration of non-corrosive liquids in hydraulic and low pressure systems, Marvel has your answer.

WATER FILTERS —In response to the great demand, we have adapted both our sump and line types for use in all water filtering applications. No changes have been made in the basic Synclinal design.

Write for complete engineering data specify oil or water.

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AMBLER CHEMICALS ACP PROCESSES PENNA.

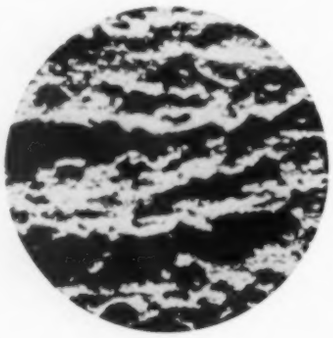
Technical Service Data Sheet

Subject: EFFICIENT PICKLING WITH RODINE®

ADVANTAGES OF "RODINE"

RODINE is used in sulfuric and muriatic acid baths for improved pickling and increased production. It meets Government Specification U.S.N. 51-I-2.

In straight line pickling of wire, rod and tubing, RODINE makes available more metal for drawing by protecting steel from acid attack. In batch pickling of sheet steel, RODINE improves the surface. In rapid, continuous strip pickling, RODINE not only saves acid and metal, but also prevents over-pickling during line shutdowns.



◀ *This steel surface was pickled in an uninhibited acid bath. Note the deep pits, and that the surface is visibly crystalline.*

This surface was pickled exactly like the one above except that "RODINE" was added to the acid solution. Only scale pockets and roll marks are visible; no pitting occurred. ▶

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES

are personally concerned. It offers the 650 men employed there ultra-deluxe facilities for bathing and cleaning up after a day underground. In addition to 45 partitioned showers, it is equipped with 1200 ceiling hangers. The hangers take up no wall space and enable each man to attach his clothes to a hanger and pull it up to the ceiling of the building where they dry. The building is tiled inside and well lighted. Other new surface structures include the general office building, lamp house and a Union Supply Co. store.

The community of Munson, located nearby the mine, is a modern village with 21 new six-room houses, two large rooming houses, and a public school. The Munson school is among the most modern in the county and has every convenience for aiding the children in their studies. One side of the school is almost entirely window glass.

RESEARCH LABS ARE COMBINED

▲ The research department of Sharples Chemicals, Inc., will be integrated with the research and development division of the parent company, the Pennsylvania Salt Manufacturing Co. The integration will occur between June 15 and September 15. Meanwhile, laboratory facilities at Whitemarsh Hall are being considerably extended by the conversion of additional rooms to laboratories and rearrangement of existing facilities to provide not only for the addition of Sharples research personnel but also to increase Pennsalt's facilities.

MIT DEDICATES NEW METALS PROCESS LAB

▲ Dedication exercises for the new Metals Processing Laboratory at the Massachusetts Institute of Technology were held recently. The new building, provided by a gift of $1,000,000 from the Alfred P. Sloan Foundation, Inc., marks a step of significant progress in education and research in all types of metal forming and machine tool work.

The Metals Processing Laboratory is located on the main MIT campus at the corner of Massachusetts Avenue and Vassar Streets with direct

personal contact . . .

a sure way to keep abreast of important developments in the Steel Industry

The big 1952 Iron and Steel Exposition will enable you to see and hear . . . in Person . . . key steel industry executives and operating men whose papers and discussions will give you a wealth of information on the industry's plans for the present and future. Time and money saving ideas on improved production methods, equipment, supplies and services exhibited by the world's leading manufacturers will help you improve your own position and do a better job for your company. You can't afford to miss it.

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Sept. 30, Oct. 1, 2 and 3

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access to the Guggenheim Aeronautical Laboratory.

The building, which measures approximately 52 by 244 ft, has 67,000 gross sq ft of floor space.

WESTINGHOUSE TO BUILD SOUTHERN METER PLANT

▲ A new multi-million dollar plant, more than 500,000 sq ft in size will be built in Raleigh, N. C. by Westinghouse Electric Corp.

The plant will manufacture watthour electric meters. It is being constructed to provide additional facilities at the division's Newark, N. J., headquarters plant where watthour meters, electrical instruments, and protective electrical relays are made. On completion of the Raleigh plant, all meters will be manufactured there.

The plant is part of Westinghouse's $296,000,000 expansion program, the second such undertaking since World War II. The first, begun in 1946 and completed last year, involved the expenditure of more than $130,000,000 and increased production 50 per cent. The current expansion program is expected to increase Westinghouse production another 50 per cent.

To initiate the new plant's construction, ground will be broken within the next few weeks on a 100-acre site located in Wake County just north of Raleigh. Materials and equipment required to build and operate the plant have been allotted by federal defense authorities. The expected completion date for the plant is July 1, 1953.

STEEL & WIRE TO REBUILD COKE OVEN BATTERY

▲ Plans to rebuild a battery of 45 coke ovens at the Cleveland, Ohio, coke works of American Steel & Wire were announced recently by A. J. Hoyt, Cleveland district manager of this U. S. Steel division.

In making the announcement, Mr. Hoyt pointed out that the new installation, which it is hoped will begin July 27, will feature a new collecting main. Smoke which develops at the time when a coke oven is charged will be sucked into this main by special aspirators.

"This feature, plus the fact that the ovens are being rebuilt from the ground up, are a very substantial contribution to American Steel & Wire's overall program in co-operation with

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You need this up-to-the-minute 56-page edition of Bristol's famous book if you're involved with thermocouples and pyrometers of any kind. It's free for the asking. Here's what you get in its three, fact-packed sections . . .

1. You get a User's Manual...filled with data you'll constantly refer to for the right thermocouple and protection tube for every purpose. Included are tables, charts, etc., on Factors Affecting Thermocouple Life, Corrosion and Poisoning, Thermocouple Reproducibility, Proper Location and Installation of Thermocouples, etc.

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The Proven Gear-Type Coupling With Fully Crowned Teeth . . . A Major Improvement In Gearing. This proven gear-type coupling with fully crowned teeth is being utilized in solving a wide range of power transmission problems other than those common to ordinary gear-type couplings.
Pat. & Pat. Pending

THIS FUNDAMENTAL IMPROVEMENT in gear tooth design practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement. This tooth design accomplishes tight fit on the crown as well as on the flanks. It is the first gear tooth on which all the load is carried on strong flanks rather than tooth edges. It reduces backlash to a minimum. These advantages, plus thrust compensation, and correction for angular and lateral misalignments give maximum relief from coupling failure grief.

Amerigear Couplings, made in several standard types, are available for standard shaft sizes and a wide range of speed and load capacities. Catalog of standard type Amerigear Couplings is available on request. Amerigear Power Transmission Engineers are available for consultation.

AMERICAN FLEXIBLE COUPLING COMPANY

Originator of the Amerigear Fully Crowned Tooth

Sales Offices in Principal Industrial Centers

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AFFILIATE OF J. A. ZURN MFG. CO.

Write on your Business Letterhead for further information regarding *Amerigear Couplings* with the *Fully Crowned Teeth* and Catalog 501.

Also Manufacturers of
The Original "Oldham Type" American Flexible Coupling

the community in reducing air pollution," Mr. Hoyt said.

The coke ovens produce about 500 tons of coke per day. It will take about four months to complete the rebuilding job.

GE IS BUILDING NEW TRANSFORMER PLANT

▲A multi-million dollar transformer manufacturing plant, providing employment for about 1700 persons, will be built at Rome, Ga., by the General Electric Co. Its construction will be begun at once and will be completed by mid 1953.

The plant will consist of two large manufacturing buildings, an office building, and a number of outlying service buildings, all constructed of steel and transit siding.

Production at the new plant will begin immediately following its completion, with full production capacity expected to be achieved in 1955.

Some classes of power transformers and large distribution transformers, representing a total of 5½-million kilivoltamperes or the equivalent of 7⅓ million hp of electrical energy, are expected to be produced annually at the new facilities.

Transformer ratings to be manufactured at the new plant will range from 300 kilivoltamperes to a maximum of 7500 kilivoltamperes, 69 kilivolts and below. Included will be liquid-filled transformers of conventional type, transformers for load center unit substations and master unit substations, and network transformers.

AISE EXPOSITION TO SET RECORD

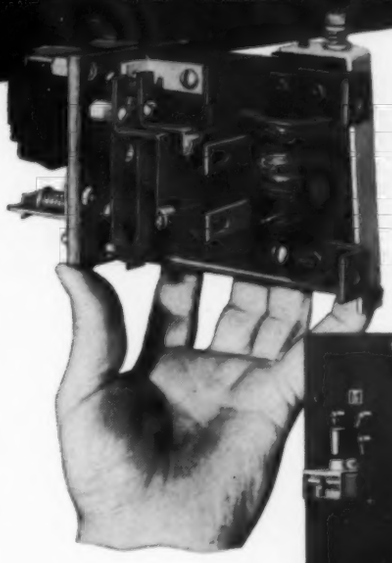
▲ Almost 200 exhibitors have reserved booths for the 1952 Iron and Steel Exposition, to be held in Cleveland Public Auditorium September 30 to October 3. The Association of Iron and Steel Engineers, sponsors of the Exposition, reports that this year's show, the 27th of its kind, will be the largest in the series, with exhibits, displays and demonstrations in three separate halls of the auditorium.

Purpose of the Exposition, the only show held for the iron and steel producing industry, is to acquaint executives and personnel of iron, steel and allied industries with the latest developments and technical advancements aimed at facilitating production or

NON-STOP OPERATION SAFEGUARDED

by EC&M THERMAL-MAGNETIC OVERLOAD RELAYS

set at 90% to 110% full load current



¾ rear view shows independent thermal and magnetic tripping elements — both are adjustable. Relay is front-connected, removable as a unit from the mounting-base.

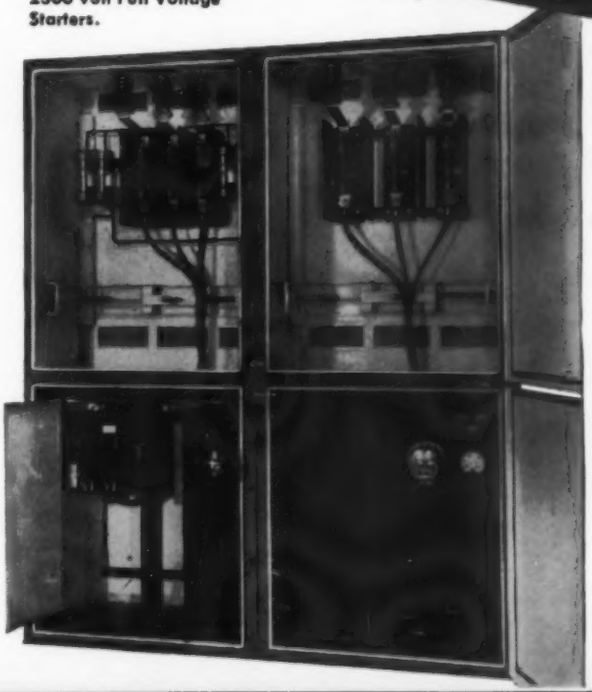
In a certain chemical processing cycle motor-drives operate up to six months without stopping. Continuous operation is essential until the product is completely processed and the machines cleared. Ambient temperatures are high.

To safeguard the insulation of these motors—by keeping temperature rise within safe limits—EC&M 2300 volt Motor Starters with EC&M NEW Type ZTM THERMAL-MAGNETIC Overload Relays were chosen.

These new Relays couple motor current directly to thermal action through a transformer for quick, positive response. Depending upon the motor load and ambient temperature, the thermal element of these Relays is adjusted from 90 to 110% Full Load Motor Current. Thermal reset time is short. Magnetic instantaneous operation minimizes damage under fault current conditions.

For improved motor protection, investigate EC&M THERMAL-MAGNETIC Overload Relays.

Type ZTM Overload Relay Panel with Time-Delay Under Voltage Protection feature is mounted in the lower compartment of EC&M 2300 volt Full Voltage Starters.



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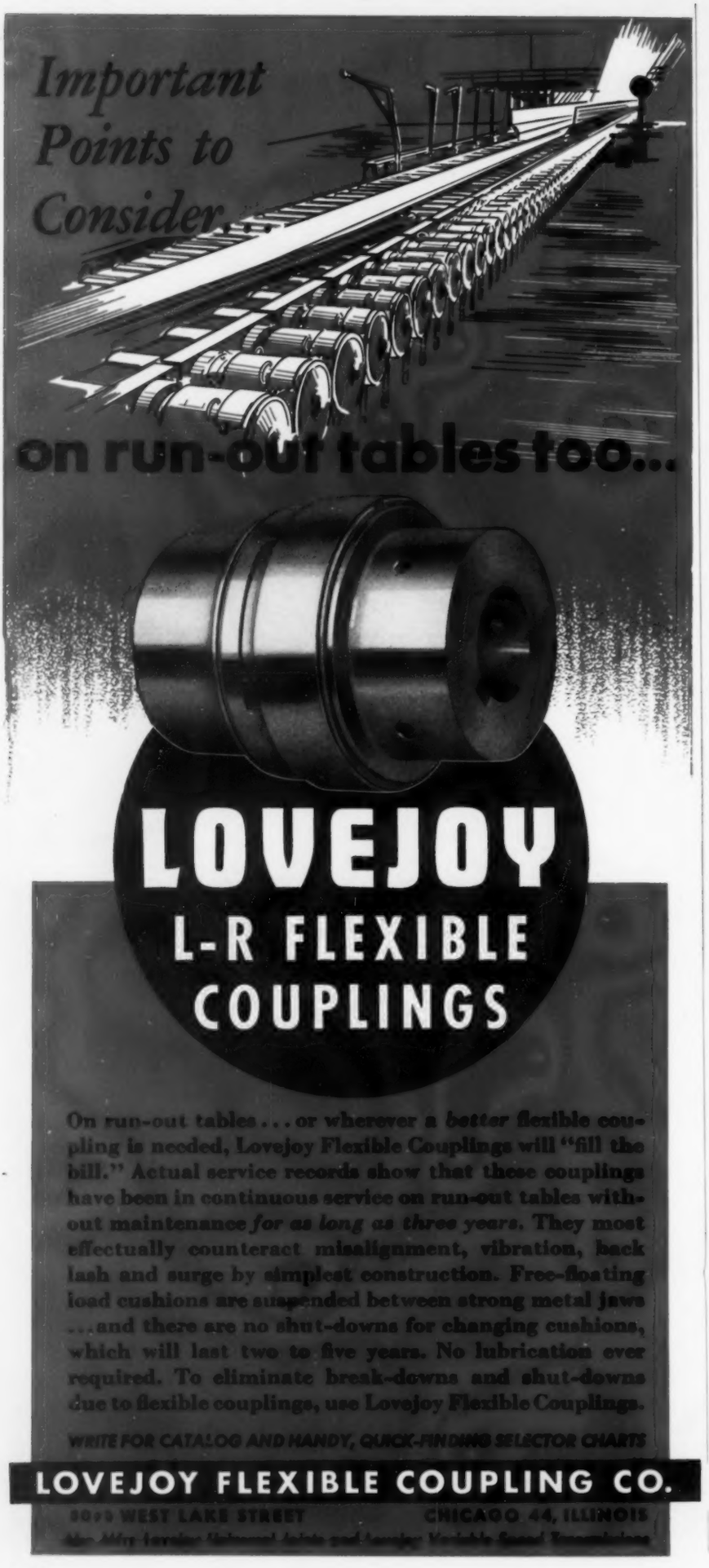
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on run-out tables too...
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L-R FLEXIBLE COUPLINGS
On run-out tables . . . or wherever a better flexible coupling is needed, Lovejoy Flexible Couplings will "fill the bill." Actual service records show that these couplings have been in continuous service on run-out tables without maintenance for as long as three years. They most effectually counteract misalignment, vibration, back lash and surge by simplest construction. Free-floating load cushions are suspended between strong metal jaws ...and there are no shut-downs for changing cushions, which will last two to five years. No lubrication ever required. To eliminate break-downs and shut-downs due to flexible couplings, use Lovejoy Flexible Couplings.
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promoting greater plant efficiency. Attendance of over 10,000 is expected for the four-day Exposition, which will be held concurrently with the Annual Convention of the Association of Iron and Steel Engineers.

Combined with the Exposition, for the interest of operating and supervisory personnel in attendance, will be technical sessions of the AISE Convention. Open to everyone attending the Exposition, both members and non-members of the Association, the technical sessions will include programs devoted to various phases of steel production: electrical, lubrication, operating practice, rolling mill, training, standardization, mechanical and combustion.

The program has been integrated so that men attending can hear at least two days of discussion on their preferred subject and also view all of the exhibits.

The Iron and Steel Exposition requires no registration fee for persons associated with the iron, steel and allied industries. Tickets will be widely distributed throughout these industries, and also are available, upon request, from AISE headquarters, 1010 Empire Building, Pittsburgh 22, Pa.

SWITCHGEAR LAB OPENED IN PHILADELPHIA

▲ Short circuits of 5,250,000 kva, the most powerful ever produced in a research facility, are created for power-equipment tests in the General Electric Co.'s new switchgear development laboratory officially opened June 19 in Philadelphia, Pa.

These power surges are used in developing, designing and testing circuit breakers and other power equipment used in utility and industrial power systems.

Two generators, designed especially for testing and the largest ever built for short-circuit testing, combine to provide the necessary power. When operated in parallel, the two units can deliver 5,250,000 kva asymetrical or 3,200,000 kva symmetrical at 15.5 kv, 3 phase.

The laboratory, located on a tract near Philadelphia's International Airport, consists of a control building, a test building, and a high-voltage yard.

The one-story, brick-and-steel control building houses the intricate controls and instruments used in conducting short-circuit tests, as well as

HOW DO YOU KEEP 'EM IN CHIPPING SHED IN TODAY'S MANPOWER RACE?

With every industry competing for all available workers, modernization of your billet-conditioning methods is *more than ever a MUST!*

When you install Bonnot Billeteers, you not only eliminate man-killing hand labor jobs but, also, save time — cut costs — increase production — reduce personnel turnover.

In fact, the many employers who already have taken this forward step, report all these practical gains with Bonnot Billeteering:

- Costs cut 56%.
- Better work, 10 times faster.
- Chips 100% recoverable.
- Excessive re-melting eliminated.
- Inventories reduced.
- Dependable scheduling.
- Steady flow of clean billets, ready for rolling.
- Easy operation of Billeteer.
- Super safety — 490,000 man hours with only one disabling accident.
- Workmen like the job — "gripes are out."

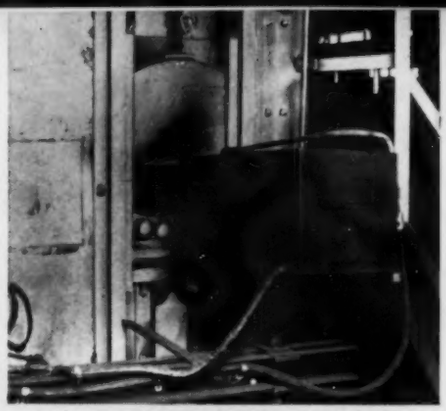
Let us — in terms of your plant — translate the "Billeteer Story of Savings, Safety and Schedules" providing jobs men *ASK FOR AND STAY WITH.*

Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

The
TIMKEN
TRADE-MARK REG. U.S. PAT. OFF.
Company
Improves TUBE
MILL Operation



"Utiliscope" Camera looks directly into furnace at charging end.

With the
DIAMOND "UTILISCOPE"
(WIRED TELEVISION)

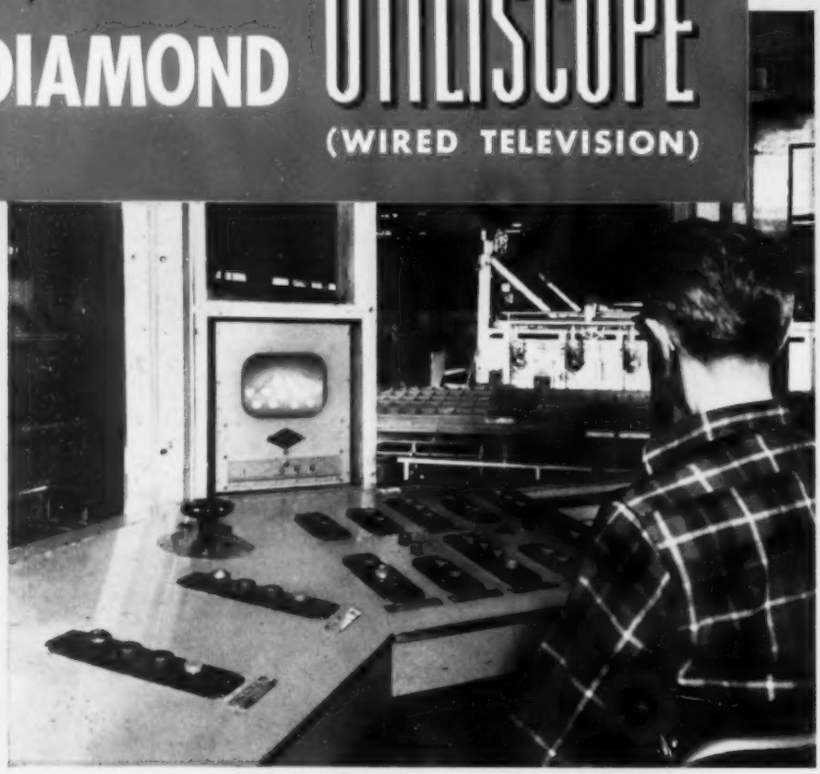


Image of furnace interior on "Utiliscope" viewing screen, right in front of dispatcher 80 feet away.

In a seamless tube mill of The Timken Roller Bearing Company, both the mill and the heating furnace are controlled by a single dispatcher. Tubes are automatically fed into the furnace sidewise . . . travel through on a conveyor. To watch both the mill and the furnace, the dispatcher must be about 80 feet from the furnace charging end.

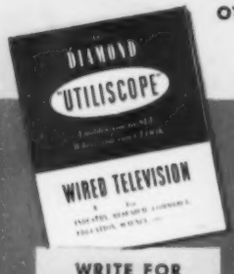
Formerly a second man was required at the charging end to avoid tube "pile ups" in the furnace. Now a Diamond "Utiliscope" (Wired Television) Camera looks directly into the furnace . . . the image is brought to a viewing screen right in front of the dispatcher. It's easy for him to maintain even furnace feed and avoid "pile ups."

This is one of many examples of improved operation with a saving in cost that has been made by using the "Utiliscope". For further information, write for Bulletin 1025-E.

OTHER USES include studying destructive tests of engines, checking remote gauge readings, viewing nuclear research, etc.

The "Utiliscope" Reg. U. S. Pat. Office.

4826



WRITE FOR BULLETIN 1025T

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO • OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured
Quality Equipment For Industry

administrative offices and record storage facilities. Located about 50 yards from the test building and 25 yards from the test yard, this structure is equipped with panoramic shatterproof windows through which engineers at the main control board and in the administrative offices can watch the equipment being tested.

Briefs . . .

▲ M. E. Cunningham Co. has moved their plant and office to 1025 Chateau Street, Pittsburgh, Pa.

▲ Speer Carbon Co., Saint Marys, Pa., and its subsidiaries, Jeffers Electronics, Inc., DuBois, Pa., International Graphite and Electrode Corp., Niagara Falls, N. Y., and Speer Resistor Corp., Saint Marys, Pa., have consolidated into one company, the Speer Carbon Co., with headquarters at Saint Marys. The various subsidiaries henceforth will operate as divisions of Speer Carbon Co.

▲ Rust Furnace Co. has completed three new batteries of soaking pits for the Algoma Steel Corp., Ltd., at Sault Ste. Marie, Ontario, Canada, with an additional battery of the three-hole soaking pits and one new billet heating furnace scheduled for completion shortly.

▲ Chemical Plants Division of Blaw-Knox Co. has been awarded a contract by the Tennessee Coal & Iron Division, United States Steel Co., Fairfield, Ala., for the engineering design, procurement, and construction of ammonia unloading facilities. This project is an expansion of existing facilities which had previously been constructed by Chemical Plants Division.

▲ Metal Carbides Corp., Youngstown, Ohio, announces that it will commence construction in the near future of a $1,000,000 plant on a 17-acre site located at Mathews Road and Southern Blvd., Boardman, Ohio, a suburb of Youngstown. The new facility will have a monthly capacity of approximately 25,000 lb of tungsten carbide metal, tungsten alloy heavy-metal, titanium metal and other special alloys made from powdered metals. Certificates of necessity have been granted the company.

TRANTINYL

guides the steel industry

YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

TREADWELL

STEEL PLATE CONSTRUCTION

DISTILLATION CYLINDERS
9'-0" DIAMETER • 126'-0" LONG • 131,000 LBS. EACH.
EACH CYLINDER SHIPPED IN ONE PIECE

HOMOGENEOUS LEAD LINED EQUIPMENT
OPEN HEARTH AND HOT METAL LADLES
STEEL PLANT TRANSFER CARS
HYDRAULIC GATES
PRESSURE VESSELS
PENSTOCKS
PIPING
OF

WELDED OR RIVETED CONSTRUCTION

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PITTSBURGH 22, PA.
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LOW COST METHOD OF ELECTRICAL DISTRIBUTION

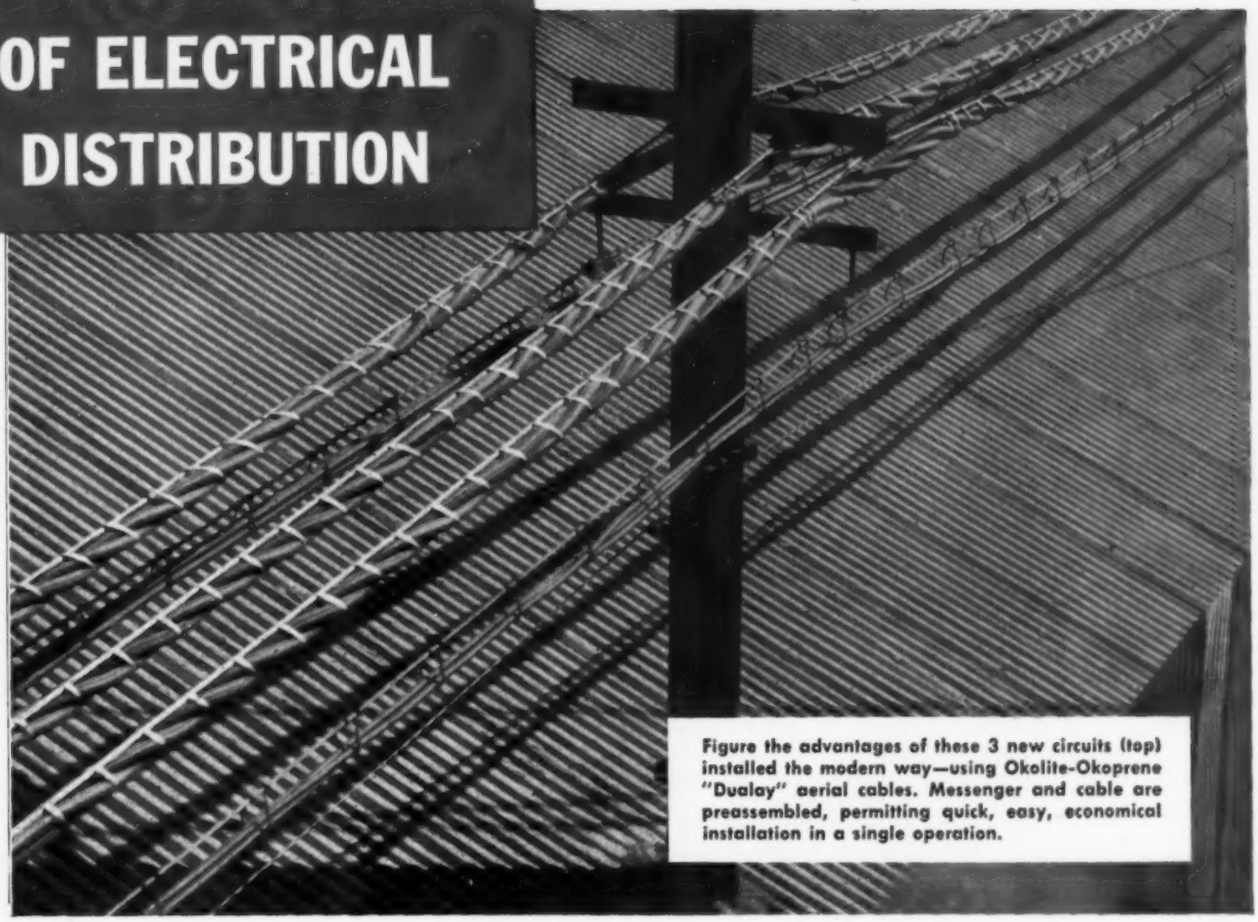


Figure the advantages of these 3 new circuits (top) installed the modern way—using Okolite-Okoprene "Dualay" aerial cables. Messenger and cable are preassembled, permitting quick, easy, economical installation in a single operation.

Okolite-Okoprene self-supporting aerial cable systems can solve a number of electrical cable problems in heavy power-consuming plants.

In such plants as steel, chemical, petroleum, glass, paper—or any fabricating and processing industry—an Okolite-Okoprene aerial cable system offers:

Money-saving advantages over duct systems.

Operational advantages over open wire circuits.

Preassembled Okolite-Okoprene self-supporting cable can be installed in a single operation quickly, easily and economically, often by making use of existing structures. Line taps and splices are simple. And of course there is no need for expensive trenching and ducting.

Because of its extremely high dielectric strength, Okolite-Okoprene gives better voltage regulation, eliminates flashover outages, and provides greater safety to personnel than conventional overhead wiring. Long, trouble-free service is assured by Okonite's famed processing methods. Premium materials, exclusive manufacturing techniques and proved formulas for insulation and sheath, combine to resist attack from moisture, heat, weather, dust- and acid-laden atmosphere.

Bulletin IS-1058 gives 52 pages of facts on why Okolite-Okoprene self-supporting aerial cable is truly an economical buy. Write for it today. The Okonite Company, Passaic, N. J.

The best cable is your best policy

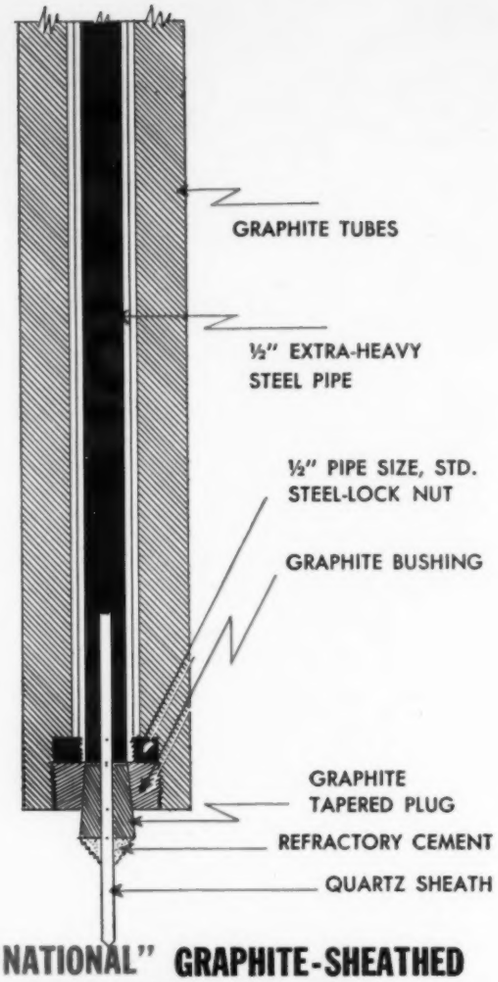
OKONITE SINCE 1878 *insulated wires and cables*

9026

In Furnace and Foundry...

These SMALL PARTS do a BIG JOB

● High temperature applications of "National" Carbon and Graphite are not limited to big-tonnage items. A part of National Carbon's service is to develop *any* application, however small, where the unique properties of carbon and graphite assure a convenience and economy to the user. In the following two instances, a few *pounds* of graphite serve literally *tons* of metal . . . efficiently and at a saving.



"NATIONAL" GRAPHITE FLUXING TUBES

Can't be equalled by any other material for the introduction of purifying gases into molten metal. Graphite won't melt in the bath, can't contaminate the metal. Its low coefficient of expansion prevents cracking and spalling. Metal and dross do not adhere tightly to it. And whatever gases are used, graphite will not corrode.

"NATIONAL" GRAPHITE-SHEATHED THERMOCOUPLE ASSEMBLY (Typical)

Only graphite could provide the degree of low-cost, trouble-free protection required by thermocouple assemblies of this type for the immersion method of measuring open hearth and electric furnace bath temperatures. Reclamation and maintenance for re-use are simple, quick, and economical. Molten metal won't stick to the graphite parts and they're immune to thermal shock.

HERE'S HOW TO LICK HY HEET

National Carbon Company
30 E. 42nd Street
New York, N. Y.

PLEASE SEND INFORMATION ON:

☐ Thermocouple Sheath Parts ☐ Fluxing Tubes

NAME_____

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The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

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A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
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Montreal, Toronto, Winnipeg

LOW LIGHT BILLS . . .

. . . mark phenomenal acceptance of "EVEREADY" No. 1050 Industrial Flashlight Batteries by a broad cross-section of industry. Delivering twice the usable light of any battery we've ever made before, it will not swell, stick or jam in the flashlight . . . has no metal can to leak or corrode.

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

James M. Darbaker has been appointed director of distribution and availability for United States Steel Co., Pittsburgh, Pa. In his new position, Mr. Darbaker will be responsible for planning the distribution of products manufactured by U. S. Steel. Mr. Darbaker, after many years in plant supervision, was named general manager of sales, in 1949, the position he occupied at the time of his present appointment.

Gerald G. Hatch was named director of research and development for Quebec Iron and Titanium Corp., Montreal, Quebec, Canada. Dr. Hatch will be located at the Sorel works of the company.

Carl A. Salmonsen has been named acting general manager of the General Electric Co.'s control department at Schenectady, N. Y. Mr. Salmonsen replaces **Karl R. VanTassel** who was recently appointed general manager of the Knolls Atomic Power Laboratory — operating department in Schenectady. Mr. Salmonsen has been general manager of the industry control department since February of this year, and will continue in that post along with his new assignment.

John M. Appel was named general manager of Farmers Engineering and Manufacturing Co. with headquarters in Pittsburgh, Pa. Mr. Appel was formerly for 17 years with Pittsburgh Plate Glass Co. as glass manager of the Pittsburgh branch.

Douglas O. Yoder has been elected president of the Yoder Co. to succeed **John I. Lucas,** who is retiring. Mr. Lucas has been with Yoder Co. since 1935, first as sales manager, then as vice president. He was elected president in 1945. Mr. Yoder started in the factory in 1935, later worked in nearly every department of the company, including production, engineering, sales and advertising. He became assistant to the president in 1949. **Frank R. Sargeant,** executive vice president and treasurer, is also retiring. Mr. Sargeant has been with Yoder Co. since 1936. **Edmund H. Kanzenbach,** secretary, now becomes treasurer, in addition to his duties as secretary. Other officers of the company, **William J. Kerr,** vice president in charge of production, **Norbert C. Rubin,** vice president in charge of sales, **Paul Abel,** vice president in charge of engineering, and **James Dalgleish,** assistant secretary and treasurer, will continue in their present positions.

Odd H. McCleary, vice president and general manager, Mathews Conveyer Co., Ellwood City, Pa., has been elected vice president of the Canadian subsidiary, Mathews Conveyer Co., Ltd., Port Hope, Ontario. **Chesley A. Paul,** formerly purchasing agent, Mathews Conveyer Co., has been elected vice president in charge of purchasing. **Lee Sekulski,** sales manager of Mathews Conveyer Co., has been elected a director. **L. J. Johnson,** formerly field engineer for Mathews with offices in New York City, has been named assistant sales manager, and has returned to the sales department at the home office. He has been replaced in the New York office by **Arnold Richter,** formerly of the Mathews proposal engineering group at Ellwood City.

Schaeffer E. Specht was named executive sales engineer for Research Corp., Bound Brook, N. J. Mr. Specht was formerly plant engineer for C. K. Williams & Co., Easton, Pa., and design engineer for Penn-Dixie Cement Corp., in Nazareth, Pa.

John W. Lohnes has been appointed vice president of sales for the Jeffers Electronics and Speer Resistor Divisions of Speer Carbon Co., St. Marys, Pa. Mr. Lohnes was previously vice president of sales for the Speer Carbon Co. and its International Graphite and Electrode division. He now holds that office for the entire company.

A. L. Foell was appointed technical director of the metals division of Arthur G. McKee Co., Cleveland, Ohio. Mr. Foell was formerly chief engineer of the iron and steel department. **Merrill Cox** is now general sales manager of the metals division. Mr. Cox was sales manager of the iron and steel department. **J. F. Baier** becomes chief engineer of the metals division. He was formerly assistant chief engineer of the iron and steel department. **Ben B. Frost** was named sales manager of the iron and steel department. Mr. Frost was formerly assistant sales manager of the iron and steel department.

JAMES M. DARBAKER

GERALD G. HATCH

CARL A. SALMONSEN

JOHN M. APPEL

Filling your complete needs for Steel Mill Space Conditioning—

1 CRANE CAB CONDITIONERS

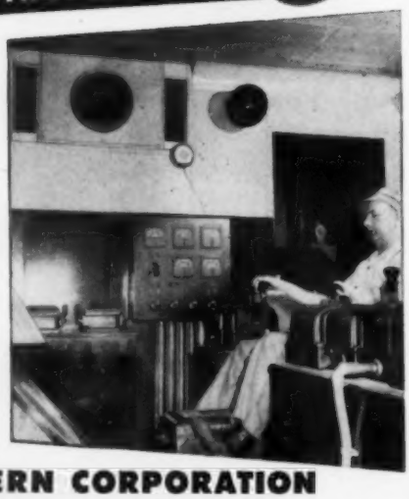
• The condenser is located at any convenient place on crane, and evaporator (cooling coil) is placed in cab. The two units are connected with refrigerant lines properly secured and protected against breakage. Condensers are air-cooled, assuring trouble-free service with but little maintenance.

2 VENTILATING HEATER FOR GENERAL PURPOSE CRANES

Available with filter unit for crane cabs and isolated spaces, this 49-VHG cab unit serves the year around, furnishing ventilation and air movement throughout the cab. Compact, efficient, inexpensive.

3 PULPITS OPERATING STANDS and CONTROL ROOMS

The line of Aire-Rectifiers is complete for all types of mill pulpits — for those of the most modern design to existing pulpits where costs must be kept down. Many are interchangeable with crane cab Aire-Rectifiers, thereby keeping service parts stocks at a minimum.



THE LINTERN CORPORATION

P. O. BOX 428 • PAINESVILLE, OHIO

R. L. Hess, Jr., has been elected a vice president of Rust Engineering Co. Mr. Hess was formerly secretary of the company.

W. Laird Davis has been elected assistant secretary of Shenango-Penn Mold Co., Pittsburgh, Pa. Mr. Davis had been an administrative assistant to the vice president and the Cleveland, Ohio, manager.

A. L. Fairley, Jr. has been elected assistant vice president of the Shenango Furnace Co., Pittsburgh, Pa.

Charles G. Crossland has been named purchasing agent for the Greenville Steel Car Co., Greenville, Pa. Mr. Crossland was assistant to the late Frederick D. Enterline who had been the company's purchasing agent for many years.

Donald K. Schleiffarth was appointed as exclusive representative of Chas. Taylor Sons Co. for the states of Missouri, Kansas, Oklahoma and southern Illinois. Mr. Schleiffarth will have his business address at P. O. Box 30, Webster Groves, 19, Mo.

J. F. Fyock was named district representative in General Electric's Construction Materials northeastern district. Mr. Fyock, who has been with the company since 1935, will be responsible for wire and cable, wiring devices and conduit products for the greater Buffalo area. His office will be at 535 Washington Street, Buffalo N. Y.

Robert M. Woodside was appointed branch industrial manager for the Industrial Division of Minneapolis-Honeywell Regulator Co. at Cleveland, Ohio. **John O. Paull** was named branch industrial manager in Los Angeles, Calif., and **Lee Alpin** was appointed branch industrial manager in San Francisco, Calif.

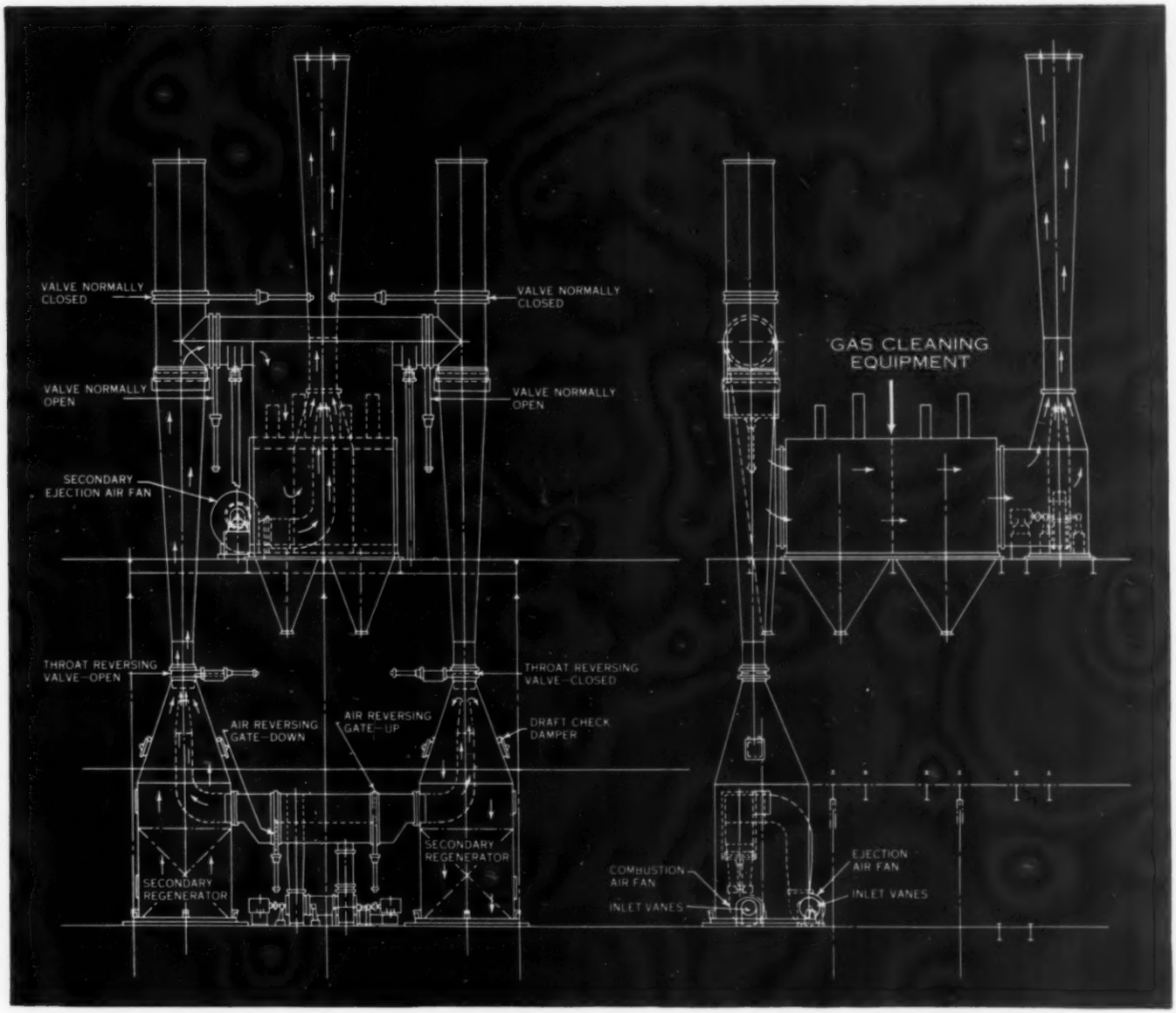
George C. Wilder was appointed a director to fill the unexpired term of the late **Jessel S. Whyte,** and was elected president of Macwhyte Co., Kenosha, Wisc. Mr. Wilder had been serving as vice president and assistant general manager.

Howard H. Casey was appointed as general sales manager for the Nicetown, Philadelphia, Pa., plant of Midvale Co. Prior to this appointment, Mr. Casey had been associated with the Camden Forge Co. for twenty-nine years, lately as director of aircraft forging sales and previously as assistant to the president.

Eugene S. Page has been named special assistant to executive vice president of the American Machine and Foundry Co., New York, N. Y. Prior to going with AMF, Mr. Page directed purchasing activities for the Great Lakes Carbon Corp., Chicago, Ill., since 1939.

Dan Reebel was named as manager of advertising and public relations for Kennametal, Inc., Latrobe, Pa. **Fred W. Pennington** continues as advertising manager of the metal working division, and **Richard L. Farris** as advertising manager of the mining tool division. Mr. Reebel was formerly Pittsburgh Editor of all Penton publications. Prior to that he was associate editor of Steel Magazine. Mr. Reebel had been advertising manager of Mesta Machine Co. for many years prior to joining Penton.

NOW Use Any Type of Gas Cleaning Equipment and Retain Advantages of Morgan-Isley System of Combustion Control . . .



MORGAN WORCESTER

The drawing above shows how readily any type or design of gas cleaning equipment can be incorporated in the Morgan-Isley System. Much less horsepower is required . . . no water for cooling the gases . . . no heat must be added to gases after cleaning to provide adequate draft and prevent condensation of moisture as gases leave stack.

This development plus the fuel saving, high heat recovery and other Morgan-Isley advantages gives added incentive to investigate now.

CCC 33

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

PITTSBURGH, PA., 2815 Koppers Bldg. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, England

S. James Aires, Jr. is now manager, commercial research, in the market development department of Lukens Steel Co., Coatesville, Pa. Mr. Aires will succeed **Richard W. Dalzell** who is now assistant manager, market development. Mr. Aires joined Lukens in November 1951 as a senior market analyst.

S. JAMES AIRES, JR.

Robert W. Suman was named chief engineer for the new Colmar, Pa., plant of Link-Belt Co. and **Norman Virkler** was appointed to succeed Mr. Suman as chief engineer for the Philadelphia, Pa., plant. The Colmar plant, north of Philadelphia, is now under construction and is scheduled to begin manufacturing operations later this year. Since 1946, Mr. Virkler has been in charge of all enclosed drive development work.

E. E. Bauer has been appointed manager of power transformer apparatus sales for the General Electric Co. at Pittsfield, Mass. Mr. Bauer has been assistant manager of power transformer sales since March, 1952.

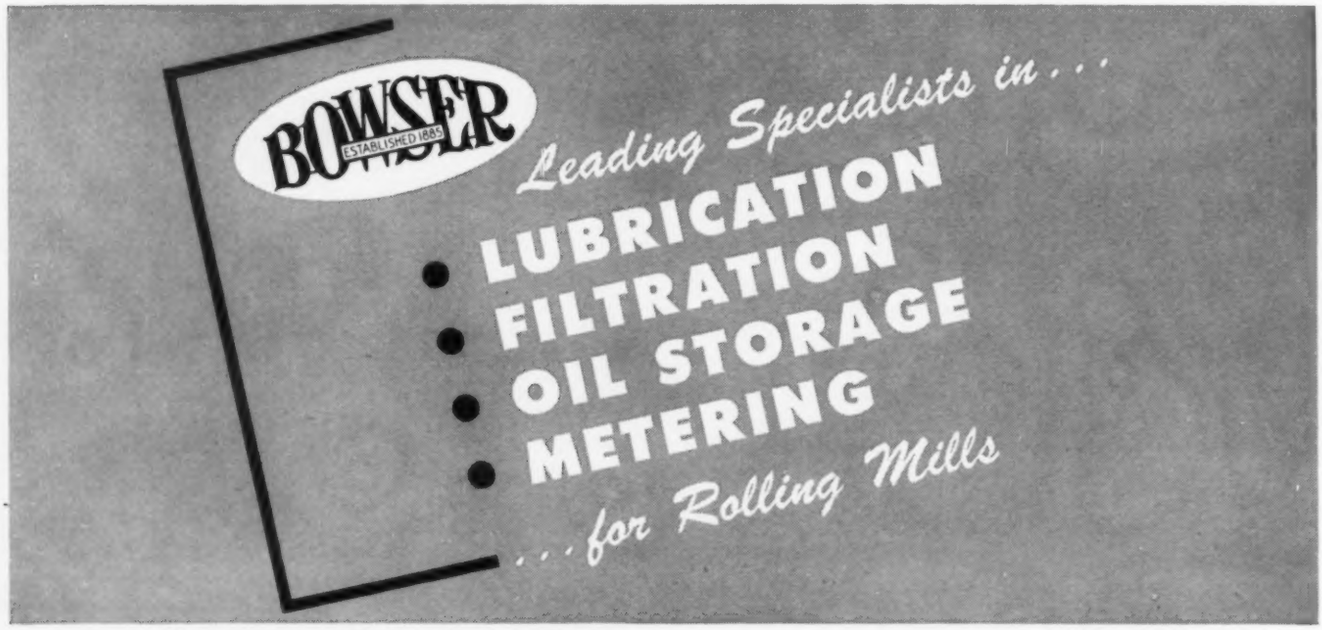
Max D. Howell, vice president and treasurer of U. S. Steel Corp., New York, N. Y., has been elected to the newly created office of executive director of the American Iron and Steel Institute, New York, N. Y.

Charles Watts was named assistant chief engineer Claymont Steel Co., Claymont, Del.

R. D. King, procurement department manager, has been appointed a departmental vice president of Koppers Co., Inc., Pittsburgh, Pa.

Thomas C. Ballou has been appointed district sales manager of the American Car and Foundry Co.'s New York, N. Y., sales district and will be in charge of railroad car and miscellaneous sales in New York, New Jersey, New England and Eastern Canada.

James H. Oakes, former sales manager for enclosed drives, was named sales manager for the Philadelphia, Pa., plant of Link-Belt Co., and **Byron K. Hartman,**



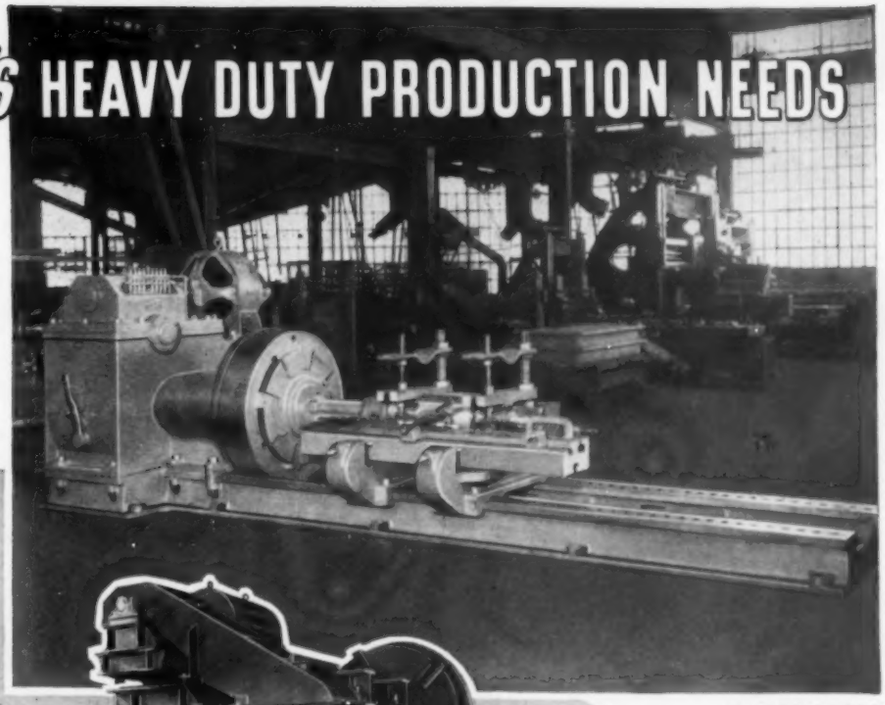
Bowser lubrication and liquid control systems have earned an enviable reputation for dependability in many rolling mills and other industrial plants. Sizes and equipment range from individual units to complete systems that serve entire plants. Bowser equipment minimizes downtime losses and maintenance costs . . . stays on the job day-in-and-day-out.

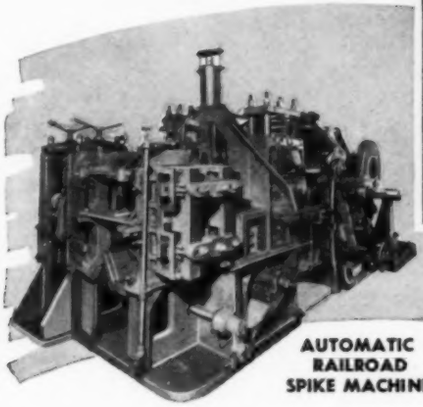
Our Engineers Are Always At Your Service

BOWSER, INC., 1370 Creighton Avenue, Fort Wayne 2, Indiana

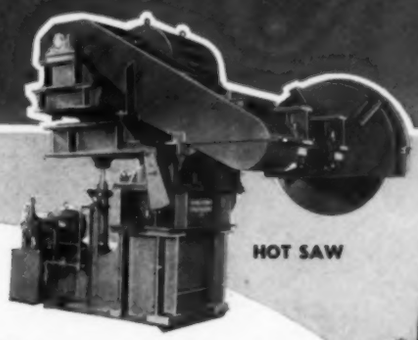
• THE STANDARD OF THE INDUSTRY FOR MORE THAN 54 YEARS •

SERVING *TODAY'S* HEAVY DUTY PRODUCTION NEEDS





AUTOMATIC RAILROAD SPIKE MACHINE

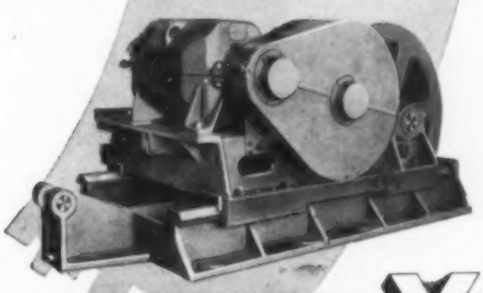


HOT SAW

18" WORM DRIVE ROLL LATHE

WELDED GEAR REDUCER

SCRUBBER and CLEANING LINE



INGOT BUGGY DRIVE

Check this List for the Products You Need

PARALLOY ROLLS (Pinch, Coiler, Tension, Steel Mill)
HYDRAULIC SLAB AND BILLET PILERS
STRIP AND SHEET OILING EQUIPMENT
SHEET SCRUBBER AND CLEANING LINES
HOT SAWS—ROCKING AND SLIDE TYPES
HOT BEDS—COOLING BEDS—TRANSFERS
BILLET EJECTORS—PINCH ROLL STANDS
SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—Traveling and Lifting Tables
Continuous PICKLING Lines—ROLLER LEVELERS
FURNACE Charging Equipment—Furnace Pushers
Strip Steel COILERS and REELS—SCRAP BALLERS
RAILROAD Spike Forming Machines—ROLL LATHES
Sheet GALVANIZING Lines—Wire Patenting Frames
Stretcher Levelers—Angle and Shape Straighteners
Rolling Mill Tables—Gear and Individual Motor Types
DUCTILE CASTINGS (80,000 PSI.)

Machinery Built to Customer's Design and Detail Drawings

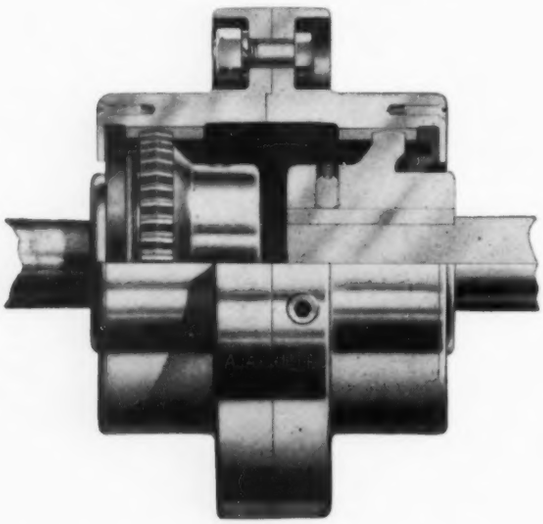
The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

AJAX DIHEDRAL

FLEXIBLE COUPLINGS
Provide for and
Protect Against Excessive
MISALIGNMENT



▶ Mill service breaks the heart of men who use ordinary couplings. Ajax Dihedral Couplings are saving thousands of hours and dollars by eliminating the necessity for precision alignment of motors and other equipment. Change-overs made in minutes instead of hours.

Stock couplings delivered off the shelf to handle misalignment up to 4 degrees. 6, 8, 10 and 12 degree couplings cut to order.

Write for the facts,—experienced coupling specialists in the field give personal service.

AJAX FLEXIBLE
COUPLING CO. INC.
WESTFIELD, NEW YORK

former assistant sales manager at Philadelphia, has become sales manager for the new Colmar plant, which will begin manufacturing operations later this year in Colmar, Pa., north of Philadelphia.

R. D. Shaw, general sales manager of Dowell, Inc., has been named director of sales. **Marshall Stirling,** sales manager of the petroleum division of Dowell with offices in Fort Worth, Tex., will move to Tulsa, Okla., as general sales manager replacing Mr. Shaw. **W. N. Estel,** who has been sales development manager, has been promoted to assistant general manager and will be directly responsible for an entirely new department of employee-public relations which is now being organized.

Robert A. Saxer has joined the Claymont Steel Corp., Claymont, Del., as metallurgist. Mr. Saxer was formerly with the Republic Steel Corp., S. Chicago, Ill., works.

Allison Butts, professor of electrometallurgy, was named head of the department of metallurgy at Lehigh University, Bethlehem, Pa., effective August 1. He will succeed Dr. Gilbert E. Doan who will leave the faculty to join the staff of the Koppers Co., Pittsburgh, Pa.

J. C. Fink was named engineering manager of industrial products for the Westinghouse Electric Corp., Pittsburgh, Pa. Mr. Fink, who formerly was assistant to the vice president in charge of engineering, will coordinate the engineering activities of all the industrial products divisions.

Grant H. Mackay, Jr., was named chief engineer of Damascus Tube Co., Greenville, Pa. and **R. L. Kelley,** was appointed service manager. Mr. Mackay served as welding engineer for the Cadillac Cleveland tank plant. Previous to this work he was associated with the Steel and Tubes division of Republic Steel Corp. Mr. Kelley was associated with National Tube division of U. S. Steel for 11 years.

E. M. Kline has been made general manager of the Huntington, W. Va., works of International Nickel Co., Inc. Mr. Kline succeeds **Herman M. Brown,** who retired on June 30 under the company's retirement plan. Mr. Brown's services hereafter will be available to the company on a consulting basis. **G. K. Crosby** was appointed assistant general manager of the works, succeeding Mr. Kline in that position.

John Tod, after 29 years with Youngstown Sheet and Tube Co., Youngstown, Ohio, resigned June 4 as a director and member of the company's executive committee. To fill the two vacancies, directors elected **Fred Tod, Jr.,** as a director and **J. L. Mauthe,** president of the company, to the company's executive committee. Mr. John Tod was vice president of Brier Hill Steel Co. when it was purchased by Youngstown Sheet and Tube Co. in 1923. He became a director of Sheet and Tube, and in 1932 was elected to the company's executive committee.

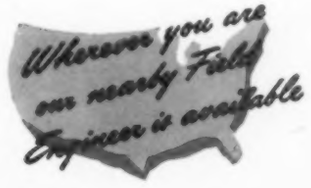
Jacques W. Lourie was appointed director of foreign sales for Hydropress, Inc., New York, N. Y. Mr. Lourie is a mechanical engineer and has been a staff member of Hydropress and its Loewy rolling mill division for more than a decade.

SOLDERING ARMATURE COIL LEADS

without a Soldering Iron?

Soldering armature coil leads to risers with National-designed induction heating equipment in the National plant.

Soldering armature coil leads to risers by hand leaves a lot to the human element. So three years ago, National developed a way to solder by induction heating. It's quicker. More uniform. *Reduces liability of premature trouble.* If you've wondered why a motor or generator repaired or redesigned by National gives such excellent service . . . it's the "little" things like this which National does, unheralded and unsung, that count so much. They mean a lot *in the long run.* Use National coils and engineering service for the unannounced advances which add so little to cost, so much to value.



NATIONAL ELECTRIC COIL COMPANY

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John D. Judge has been appointed president of Tube Reducing Corp., Wallington, N. J., to succeed the late **J. J. White.** Mr. Judge joined the firm in 1948 as executive vice president.

John W. Pennington, chief engineer of the piston ring department, Koppers Co., Inc. since December 1950, has been named executive engineer and head of the newly-created technical department of Koppers Metal Products Division in Baltimore, Md.

J. H. Spencer has been appointed manager of the northeastern region for the Sturtevant division of Westinghouse Electric Corp. with headquarters in Boston, Mass.; **H. F. Brush** has been named manager of the middle Atlantic region with headquarters in Philadelphia, Pa.; **Robert Mercer** is the new north-central region manager with headquarters in Cleveland, Ohio; **D. W. Davis, Jr.** becomes manager of the northwestern region with headquarters in Chicago, Ill.; **W. J. Oonk** has been appointed manager of the southwestern region with offices in St. Louis, Mo.; **D. M. Hutchinson** has been appointed manager of the southeastern region with offices in Atlanta, Ga.; **H. W. Rainey, Jr.** is the manager of the new south-central region with headquarters in Pittsburgh, Pa.; and **John F. Munder** is the manager of the new eastern region with offices in New York, N. Y.

W. D. Levie, production superintendent of the St. Paul coke plant of Koppers Co., Inc. since 1942, has been appointed technical adviser to the plant manager. Succeeding Mr. Levie as production superintendent will be **Jess H. Brown,** assistant production superintendent since 1942. The St. Paul plant is one of two in Koppers Gas and Coke Division.

Obituaries

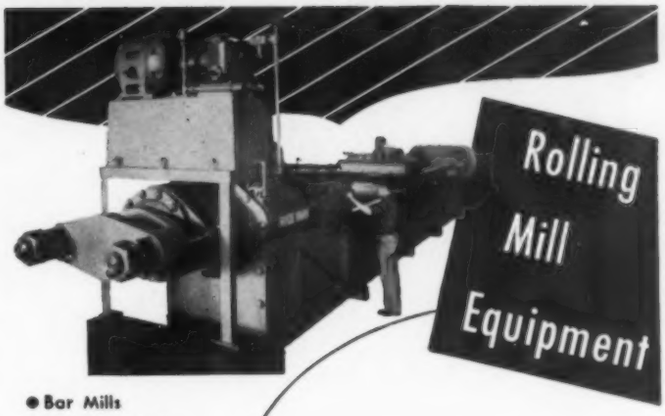
Duncan C. Macdonald, 74, who had been associated with American Steel & Wire Division of U. S. Steel for 52 years prior to his retirement in 1945, died June 4, in Worcester, Mass. From September, 1941, until his retirement in October, 1945, he was eastern district purchasing agent for American Steel & Wire in Worcester.

North Emory Bartlett, 82, former vice president in charge of sales of the Pennsylvania Salt Manufacturing Co., died June 7 at his home at Teal Point, near Easton, Md.

William J. Wardell, 64, a vice president and director of American Can Co., died recently in New York, N. Y., after a long illness. He had been associated with the can-making firm since 1903, two years after the company was formed.

Wallace C. Eshelman, 63, general superintendent of Bethlehem Pacific Coast Steel Corp's., plant at San Francisco, Calif., died recently.

Jessel S. Whyte, 61, president and general manager of Macwhyte Co., Kenosha, Wisc., died May 28.



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Outstanding in quality and in performance Hyde Park Rolling Mill Equipment has enjoyed the respect of the industry for more than fifty years.

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FOUNDRY & MACHINE CO.
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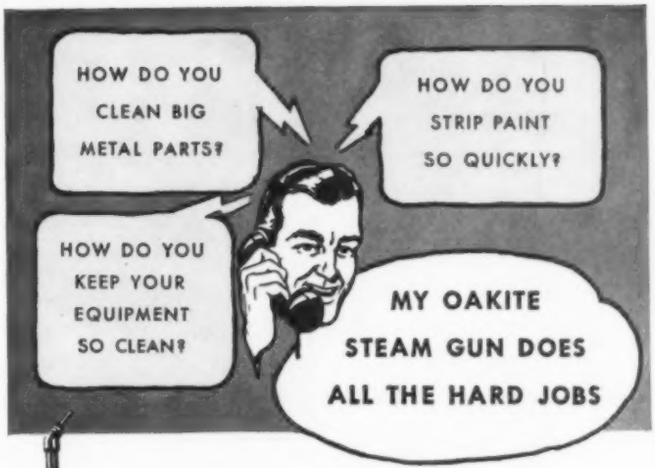
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HOW DO YOU STRIP PAINT SO QUICKLY?
HOW DO YOU KEEP YOUR EQUIPMENT SO CLEAN?
MY OAKITE STEAM GUN DOES ALL THE HARD JOBS

This man knows the best way to clean metal parts that are too large for tanks or washing machines . . . He knows the best way to strip paint from large surfaces.

His Oakite Steam Gun will clean large equipment like die casting machines, wire drawing machines, blooming mill rollers, brass reduction machines, millers and grinders, drill presses, stamping machines, etc... It will do practically every cleaning job that's too big or too difficult for ordinary methods.

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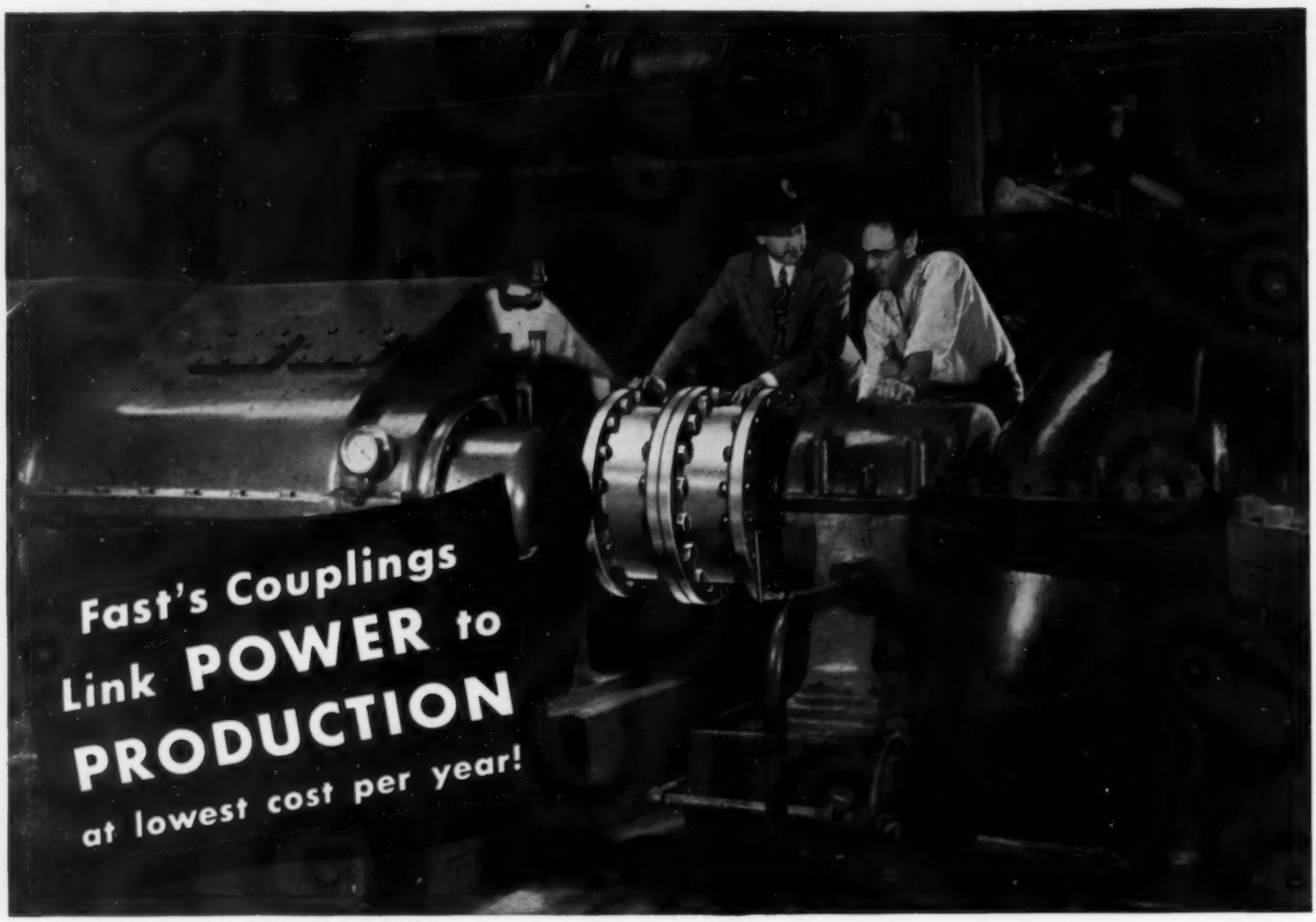

Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 217 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

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FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
217 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

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City ..... *Zone* ..... *State* .....

George W. Eppler, 55, general manager of the Monongahela division of Combustion Engineering-Superheater, Inc., died June 8.

William Walton Ford, 65, district sales manager for Youngstown Sheet and Tube Co. at Atlanta, Ga., for the last 24 years, died June 11.

Raymond E. Brown, 74, died recently. In 1904, Mr. Brown joined Heyl & Patterson, Inc., Pittsburgh, Pa., where he stayed until his semi-retirement in 1948. He served as consulting engineer for Heyl & Patterson from 1948 until his death.

Forest J. Smith, 57, assistant to the general superintendent of the United States Steel Corp.'s Fairless works in Morrisville, Pa., died June 20 in Midland, Mich. Prior to his Fairless works assignment Mr. Smith was supervisor of labor relations at the company's general offices in Pittsburgh, Pa.

C. C. Crubaugh, 64, sales engineer, Morgan Engineering Co., Alliance, Ohio, died June 15.

Karl W. Gass, 64, vice president, Amsler Morton Corp., Pittsburgh, Pa., died July 2.

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CABLE SUPPORTS AND SEALS
Complete range of types and sizes for all applications. Easy to install. Also combination support and terminators. Famous "Sali" Wedgelock inserts, tapered for locked grip. Quality construction. Competitive prices.
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FALCON HAS BEEN IN THE BUSINESS OF CUTTING YOUR OPERATING COSTS
It starts to happen immediately, like this, when you call on FALCON for Non-Ferrous Castings
FROM THE TOP on down, Falcon is a relatively small, shirt-sleeve organization of specialists. Regardless of title, the management man who takes your order PERSONALLY guides it into immediate action. And he stays on top of it until final delivery. USING his technical knowledge to assure both flawless quality of production and record service. It's a routine that protects Falcon's long-time reputation for best quality, best delivery. And it cuts your operating costs by eliminating delays and downtime due to imperfect casting practice.
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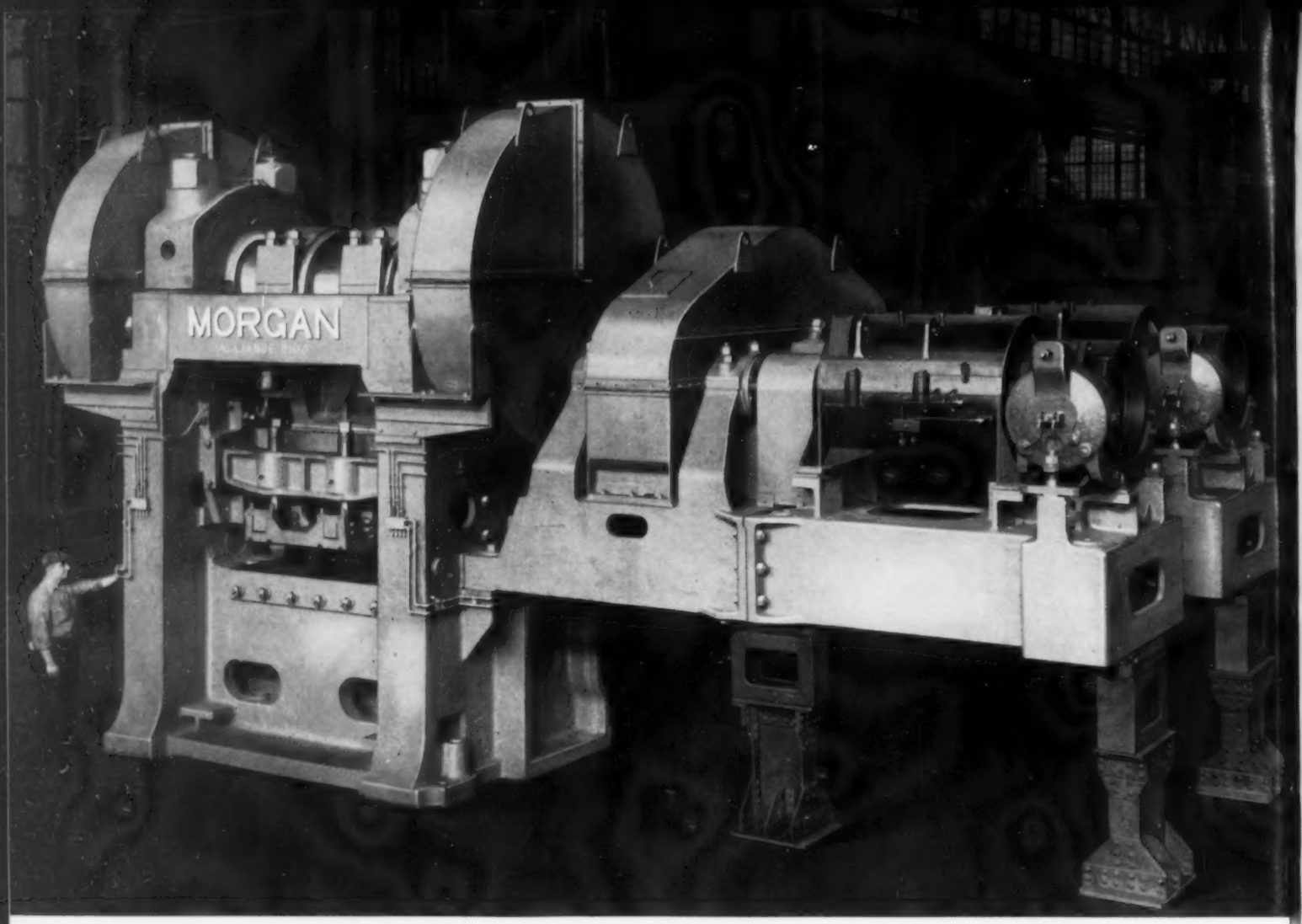

1200-TON DOWN CUT SLAB SHEAR

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DESIGNERS • MANUFACTURERS • CONTRACTORS

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SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

Illustrated is a 1200-ton hot Slab Shear of the start-stop type with twin-motor drive.

Shear has a 12″ stroke. Designed to cut maximum 51″ wide x 6″ thick stainless steel and 60″ wide x 7″ thick carbon steel slabs.

Cutting speed eight (8) strokes per minute.

Your inquiries for mill equipment will be appreciated.

Equipment News...

COMMUNICATION UNIT

▲ Farmers Engineering and Manufacturing Co. has introduced the "Femco Trolleyphone," plug-in model, 2550 series.

The new communication unit is offered as "one of the simplest, most useful communication systems ever devised" for use in mines or mills. The new plug-in model has been made more compact, and vastly easier to install and service than all previous models of similar equipment. A common communication system, each station is equipped with

a press-to-talk microphone and a clear speaker with automatic volume control. Words spoken with any microphone come out of all speakers at a natural voice level regardless of distance.

Equipment consists of transreceiver units which incorporate both transmitters and receivers, speakers and microphones.

Transreceiver units for the new model have been completely redesigned and simplified. Construction is strong and shock proof for dependability in heavy industrial use. New plug-in components make possible quick servicing when required with a minimum of down-time. Tubes and all sections are simply replaced with spares. Microphones and speakers plug in also, so that any parts may be returned to the maker for inspection and possible repair while equipment is in use. Tubes are inexpensive radio receiving tubes.

Power is taken from existing trolley wire or power line, either 250 or 550 volts d-c current drain is about ½ ampere. Installation can also be made for 110 or 220 volt a-c single or three phase, or from 6 to 40 volt batteries.

Advantages of use of these systems include closer control and supervision over far flung areas; increased production of ore, metals and manufactured products; savings in time and costs; improved morale, teamwork and safety.

D-C MOTOR

▲ The development of a new d-c motor of low inertia (small diameter armature) and high flux (strong field) designed to meet the extraordinarily fast reversing requirements of the drives for many of today's high production machines is announced by Reliance Electric & Engineering Co.

The new motor, based on the Reliance Type T heavy-duty design, makes use of two electronic circuits to impose, briefly, several times normal voltage on both motor armature and field.

Controlled within pre-determined current limits, these forcing circuits make it possible while maintaining maximum torque to reverse the motor more rapidly than has heretofore been achieved by anyone.

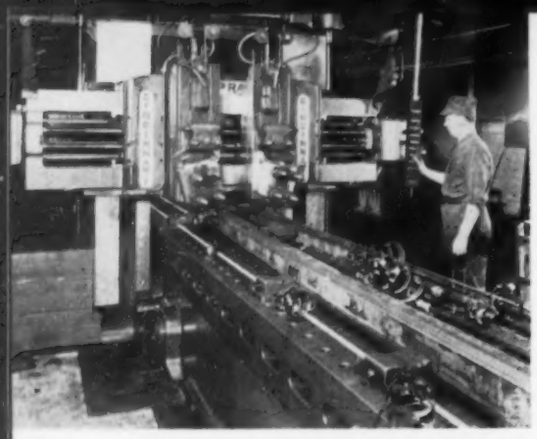
Moreover, the consistency of point of reversal is maintained because of a minimum of overtravel.

The new motor with its associated generator and electronic controls will be available in sizes from 1 to 500 hp. Motors in all sizes are force ventilated with air supplied by an integrally mounted blower.

The new motor incorporates a number of design improvements which increase its commutating ability and the high torque it develops. One is the high flux design utilized. This is based upon greater use of iron in the motor, larger air gap, thicker frames and improved holes. Other

FOLLOWER ATTACHMENT

A standard vertical milling machine is converted to die sinking by means of the Turchan follower attachment to produce irregular cavity shapes required for this forging die. Hydraulic power controls the metal-removing depth of cut in exact conformance to path of tracer over template surface. Quick setups of master and work, wider range of jobs, absence of special form tools, and uniform accuracy are important features. The attachment in no way interferes with manual operation of the machine.



This new rapid-reversing d-c motor and variable speed drive as applied to planers, incorporates newly-developed electronic controls to achieve faster and extremely accurate reversals.

construction refinements include full-length, laminated interpoles, non-magnetic interpole bolts and shims, and non-magnetic banding wire for the armature.

Use of low voltage fields on both the motor and the generator of the drive facilitates the forcing effect of the electronic circuits. The generator has one field with normal voltage of 25 volts. The motor uses two fields—one supplied from a constant potential exciter at 115 volts, the second supplied by an electronic exciter, the voltage of which is determined by the size of the motor.

Developed especially for reversing service, this electronically-controlled reversing drive provides high accelerating torque, that responds instantly to the forcing circuits of the electronic controls to provide maximum rates of accelerating and reversing. IR drop compensation and generator voltage regulation combine to maintain motor speed constant under wide changes in load. The motor field circuits regulate field current to eliminate speed drifts resulting from motor field heating.

STEAM TRAP

▲ A new and unique design in an integrally designed steam trap has been announced by Velan Engineering Co. It is the type SP, a piston-operated steam trap for applications where exceptionally large capacities are required.

This new trap, comparatively small and much lighter than other designs of similar piston-operated traps, has a 2 in. orifice with tremendous capacities. It combines the Velan 4 operation principle: 1—airvent; 2—strainer; 3—condensate discharge; and 4—check valve.

The air-discharge capacity is much larger than that of other designs. All moving parts are made from stainless steel including piston plunger, piston liner and spring. The strainer is made from heavy duty phosphor screen for pressures up to 250 psi and from stainless steel for higher pressures.

The trap can be supplied with screwed connections 1½, 2, 2½, 3 in. or with flanged connections 1½ to 5 in.

COMBUSTION SAFEGUARD

▲ Centralization of the combustion safeguard equipment for 2 to 16 burners can now be accomplished with the new multiple burner "Protect-O-

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 50 years' experience, places plenty of strength where it is required.

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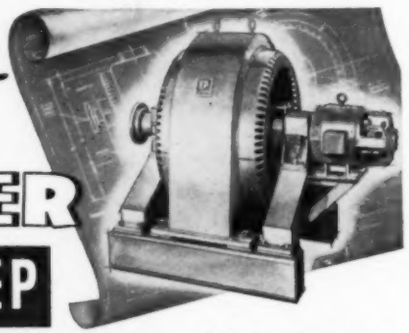

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Return coupon for information on our Custom-Engineered a-c and d-c motors and generators . . . induction motors . . . battery chargers . . . frequency changers.

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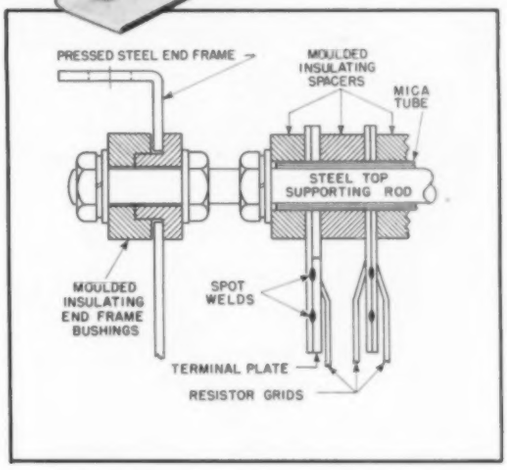
Double Insulation To Ground

The supporting rods used in EC&M TAB-WELD Resistor Sections are insulated from the steel end-frames by interlocking moulded bushings. Mica tubes are placed over the supporting rods to insulate the individual grids.

The assembled grid-stack is clamped by nuts located on the supporting rods *inside* the end-frames, making it possible to maintain *accurate mounting-hole* dimensions. End-frames are independently clamped.

In low-ampere-capacity sections, requiring a center supporting rod, interlocking spacers insulate and hold the grids firmly. These spacers have high heat-resisting properties.



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1. Corrosion-resistant alloy steel.
2. Negligible resistance change.
3. Same height, width, length.
4. Same size grid throughout.
5. Convenient tap-shifting.
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specify **EC&M Bulletin 942 *TAB-WELD* Plate Resistors**

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Glo" system recently introduced by the Industrial division of Minneapolis-Honeywell Regulator Co.

Incorporating the flame rectification combustion safeguard principle, the new system features individual flame detecting relays for each burner housed in a single cabinet. These relays are used in conjunction with a photocell flame detector in the case of oil-fired burners or with a flame electrode detector on gas or gas-piloted oil fired installations. The flame detector and relay circuit acts to shut down the fuel supply in the event of flame failure at the burner.

The cabinet also houses push-buttons, signal lights and other component parts of the safeguard circuit.

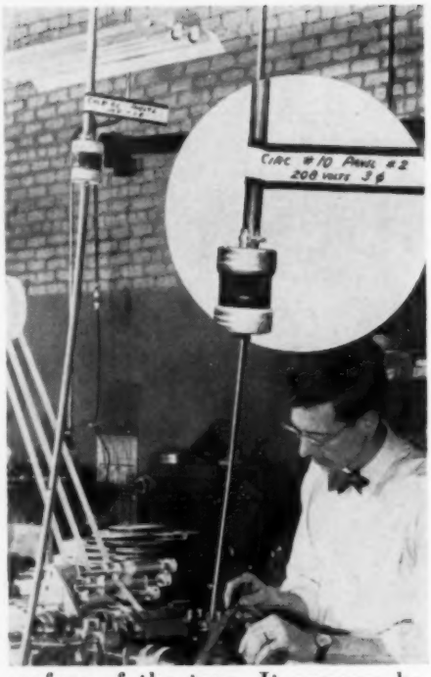
Standard systems handle 2 to 16 burners. There are three operating opinions available. A sequence light-off, in which the second pilot valve does not open until the first pilot flame has been proved; a unison light-off, in which ignition of all burners takes place simultaneously and an independent light-off, in which each burner is individually ignited.

PLASTIC TAPE

▲ What's the number of this circuit? Its voltage? A-c or d-c? How many amps? What phase? Where is the panel that serves it? Which fuse has blown?

An immediate and correct answer to one or all of these questions is frequently needed to prevent loss of time, damage to equipment or even personal injuries. While many systems have been devised to provide such answers, one of the simplest and most efficient is through use of the recently developed Labelon plastic "Write-on-it" tape — a new and unusual marking tape on which all necessary circuit data can be noted and the tape applied directly to panels, circuit breakers, switches, fuses, wall outlets and as "flags" to wires and drop cords. The new tape is pressure sensitive, sticking without moistening to any dry and comparatively smooth surface.

Labelon Tape may be written on with a pencil or any pointed instrument—but the writing is not on the



surface of the tape. It appears beneath a transparent plastic outer layer which protects it against smudging, dust, dirt, oil, water and chemicals.

Temperatures between –40 F and

when you CHANGE over to SPRAYING SYSTEMS descaling NOZZLES

If you want to materially reduce down time on rolling mills due to clogged nozzles, try Spraying Systems descaling nozzles. Large orifice diameter permits passage of practically all particles that ordinarily clog other types of nozzles. Spraying Systems nozzles produce an effective uniform flat spray, free of streaks, with an impinging force equal to over 96% of the maximum potential. Typical user is the Homestead District Works of U. S. Steel illustrated above. Nozzles are made of hardened stainless steel in a wide range of capacities and spray angles. Your inquiry is invited . . . write for Data Sheet 3997.

SPRAYING SYSTEMS CO.

3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

Also write for Data Sheet 4516 . . . Pneumatic Atomizing Nozzles for direct spray gear lubrication.

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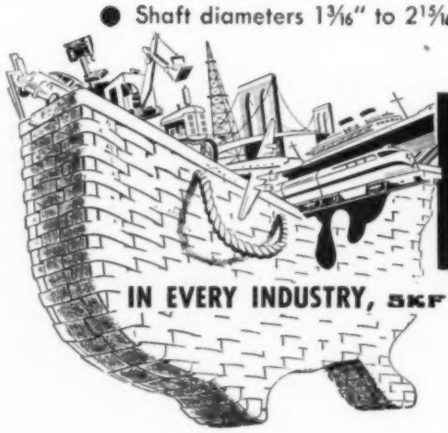
the HESS-BRIGHT "SY" UNIT PILLOW BLOCK

A new Unit Pillow Block, designed by SKF to meet tomorrow's needs of modern industry.

Here are the design features:

- SKF Red Seal, made of DuPont Fairprene, retains lubricant. Wiping action of the seal against the inner ring is practically frictionless.
- Rotating flingers exclude dirt.
- Set screws for ease of installation.
- Spherical outer ring compensates for initial misalignment.
- Alemite fitting for re-lubrication.
- Interchangeability with existing installations made possible by bolt hole spacing and center height features.
- Shaft diameters 1 3/16" to 2 15/16".

Detailed illustration of rotating flinger and RED SEAL—the extremely light tension contact seal.



SKF®
BALL AND ROLLER BEARINGS

IN EVERY INDUSTRY, SKF Puts The Right Bearing In The Right Place

From now on, the name to remember in Unit Pillow Blocks is HESS-BRIGHT "SY"—manufactured in our plants, to the same high quality standards as all SKF products. Ask your SKF Distributor to show you the HESS-BRIGHT "SY"; or write SKF direct for complete information on this *newest* Unit Pillow Block.

SKF INDUSTRIES, INC., Phila. 32, Pa.—*manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.* 7312-A

160 F do not affect the tape in any way. It is fadeless and provides a permanent label that can be stripped off one surface and reapplied to another many times without leaving a mark or losing its adhesive quality.

Four standard colors (blue, green, black and red) are available, providing a handy aid to coding, and widths from $\frac{5}{16}$ in. to 2 in. in a wide variety of roll lengths, all fitting standard dispensers or those supplied by the manufacturer.

PACKAGED PANELS

▲ A unique method of packaging panelboards has been introduced by the Trumbull Electric department of General Electric Co. While designed primarily to speed distributor over-the-counter service, this new technique, according to Trumbull, makes possible a reduction in panelboard prices without affecting quality. Thus far, the only products affected by the new packaging process are knockdown "NLTQ" panelboards.

The new method, which has already been put into practice, calls for packaging panelboard components in three separate cartons . . . one containing the box and interior, another the front, and a third containing twenty plug-in breakers. Thus, distributors can now fill on-the-spot customer orders by simply providing the required number of breakers from this third carton.

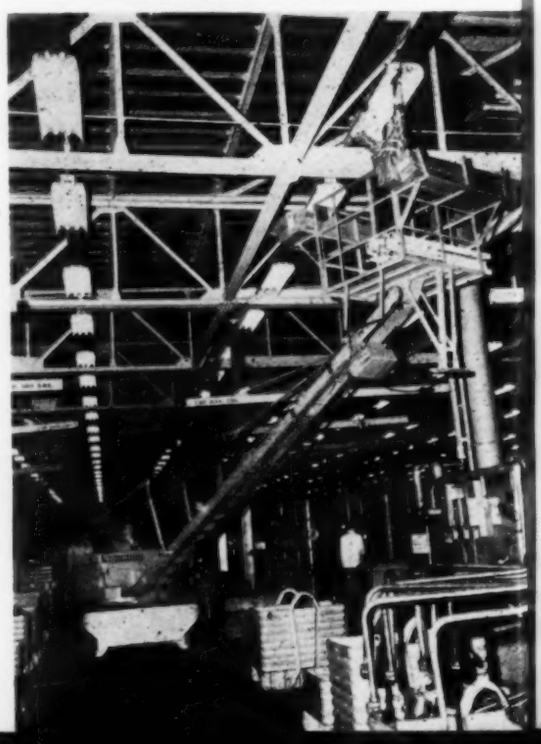
This new packaging approach makes it possible for standard lighting panelboards to be delivered from stock in a matter of seconds, and distributors whose showroom facilities permit can now sell them in bins, supermarket style.

MAINTENANCE CRANE

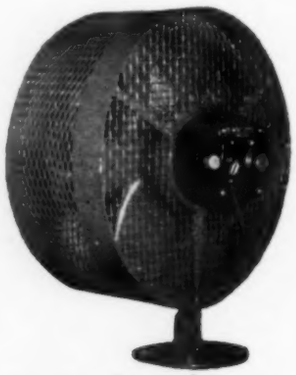
▲ Maintenance goes over with a "boom" at the new plant of Caterpillar Tractor Co. in Joliet, Ill. A 6,000-lb capacity Yale electric crane truck equipped with a new type articulated platform is used for faster, easier maintenance of lighting and other overhead equipment. The crane can position the boom and platform for overhead work above machine tools and other obstacles—in locations difficult to reach by other means.

In operation, maintenance man and material are picked up by lower-

A 6000-lb capacity electric crane truck equipped with a new type articulated platform is used to maintain lighting and other overhead equipment—in locations difficult to reach by conventional methods.

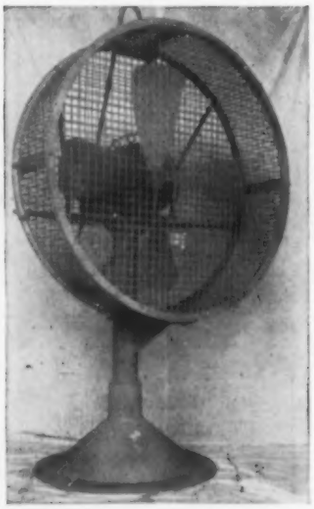


IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

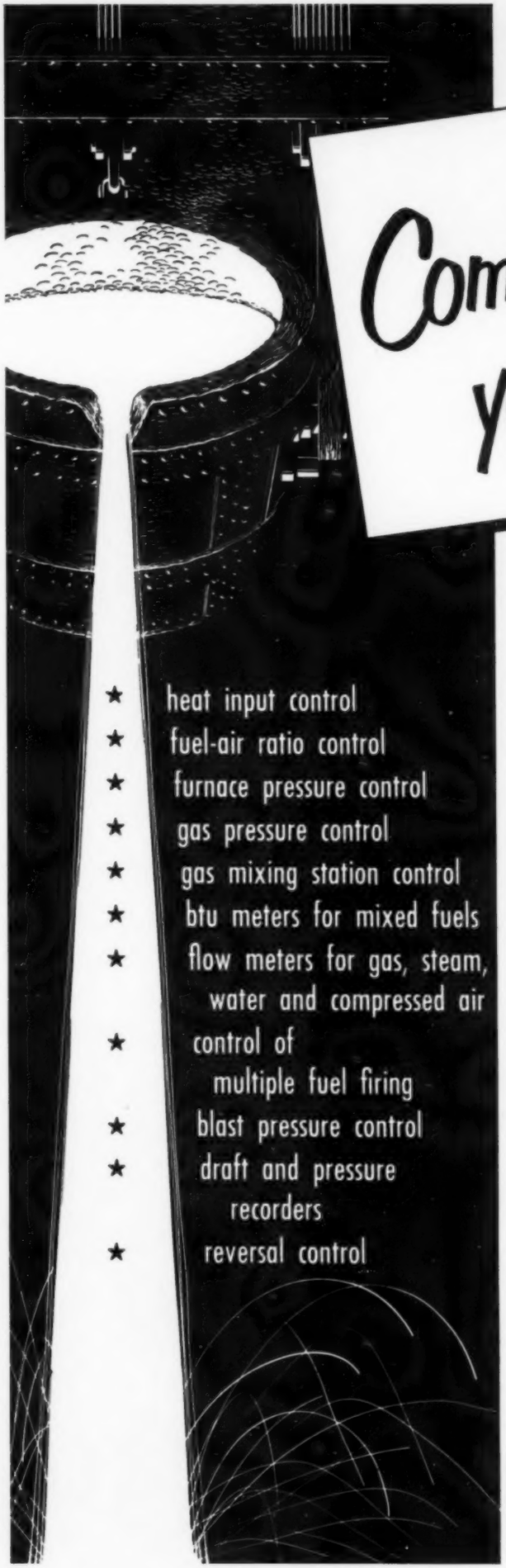
All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST., HARMONY, PA.



Combustion Control you can rely on...

- ★ heat input control
- ★ fuel-air ratio control
- ★ furnace pressure control
- ★ gas pressure control
- ★ gas mixing station control
- ★ btu meters for mixed fuels
- ★ flow meters for gas, steam, water and compressed air
- ★ control of multiple fuel firing
- ★ blast pressure control
- ★ draft and pressure recorders
- ★ reversal control

HAGAN

Air-Operated Controls and Ring Balance Flow Meters for every steel production problem.

You can depend on Hagan Air-Operated Controls for every job from the blast furnace to the finished product.

Hagan Air-Operated Controls and Ring Balance Flow Meters are specifically designed for reliable performance in connection with soaking pits, coke ovens, blast furnaces, reheating furnaces, gas distribution systems, Bessemer Converters, boiler houses, and open hearths.

Whatever YOUR control and metering problems may be, there are Hagan Air-Operated Controls and Ring Balance Flow Meters to solve them. Experienced Hagan Engineers will be glad to help you. For information, write, wire or phone:

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AERONAUTICAL
AND AUTOMOTIVE TESTING FACILITIES

ing the boom until the platform rests on the floor. Positive mechanical linkage on the boom keeps the platform parallel with the floor at all times, regardless of boom elevation. For maximum coverage from a given aisle location, the boom can be extended to lengths up to 19 ft and swing in a 270-degree arc.

This same crane truck also is used for outdoor maintenance work. Here, it can reach from the street over grass and sidewalks to service the company's street lighting equipment.

The crane truck and platform were designed and manufactured by Yale & Towne Manufacturing Co.

WIRE WHEEL BRUSH

▲ A simple application of power brushing is now saving the White Motor Co. considerable manufacturing time.

By using a wire wheel brush, manufactured by the Osborn Manufacturing Co. to remove a feather edge left after machinery cast iron sheaves, White is saving more than three and three-quarter minutes per unit.

More important is the fact that removing this edge lengthens belt life considerably.

Prior to the introduction of this brushing method, this feather edge was removed by using emery cloth with the sheave rotating on a lathe. This operation, which included mounting and unmounting the sheave, took four minutes. A wire wheel brush mounted on a stand grinder now does this operation in 15 seconds.

The flexibility of the brush permits it to blend minute surface roughness, thereby removing all possible abrasive action on the belt.

As long as two months service is being obtained from each brush, which costs less than $3.00.

AIR MOVER

▲ To remove fumes and sparks from welding operations, Eddystone, Pa., division of Baldwin-Lima-Hamilton Corp. has equipped welders in four of its shops with more than 100 portable, compressed-air type ventilating "Air-Movers." These simple and inexpensive devices have proved to be more satisfactory than a permanently installed ventilation system.

The convenience of portability of the Mine Safety Appliance Lamb "Air-Movers" permits welders to put them close enough to welding operations to remove practically all fumes and sparks, discharging them into the upper atmosphere of the building. Although the movers are nearly three feet long, their total weight of only five pounds is largely in the base so that they stand readily in almost

(*Please turn to page 188*)

COOLER OPERATION

another reason why
OHIO is the *PREMIER* mill magnet

Morning . . . noon . . . night—Ohio Magnets lift efficiently, uniformly over extended periods of time because they operate *cooler*.

Take this husky Ohio Bolted Magnet. The heavy-duty copper strip coils are wound in longer lasting inorganic insulation and carefully sealed with plenty of non-cracking asphaltum.

For extra magnet life, extra magnet value—specify Ohio Magnets. And remember, *Ohio Magnets lift as much or more than other magnets of the same size.*

A-5446

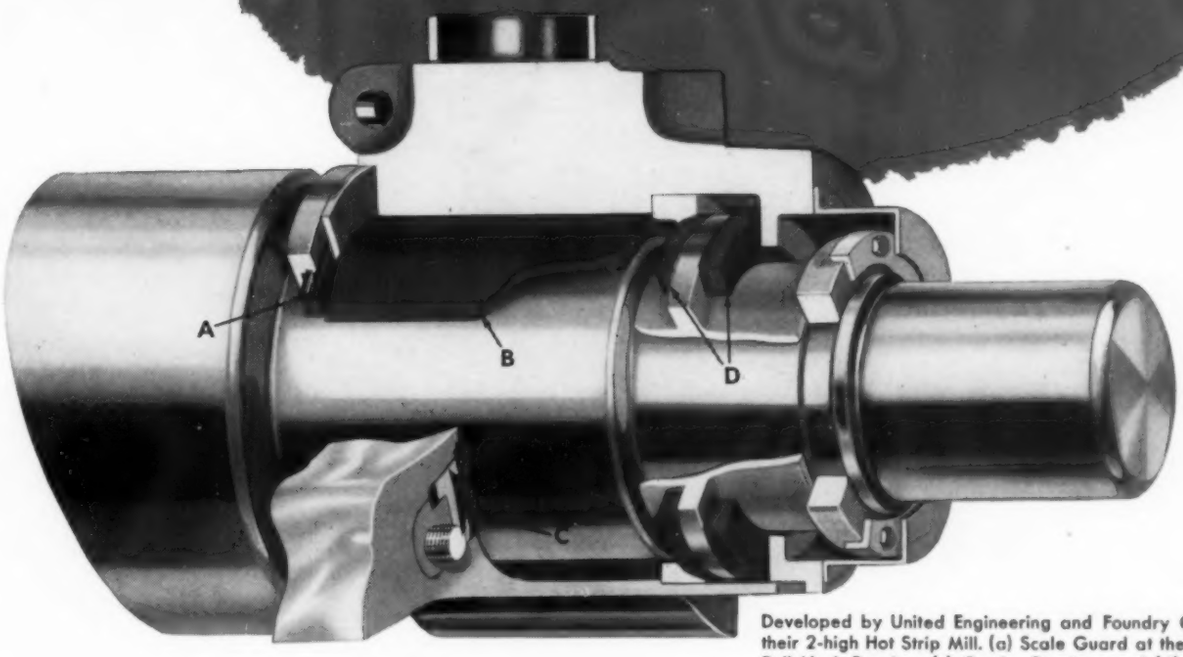
THE OHIO ELECTRIC MFG. CO. • 5900 MAURICE AVENUE • CLEVELAND 4, OHIO

CHESTER BLAND
President

Ohio ELECTRIC

NEW...

Enclosed roll neck assembly with A-B-K bearings for more efficient mill operation

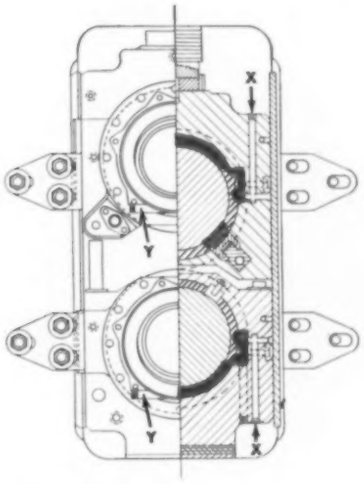


Developed by United Engineering and Foundry Company for their 2-high Hot Strip Mill. (a) Scale Guard at the roll fillet; (b) Roll Neck Bearing; (c) Carrier Bearings and (d) Thrust Rings.

Fully enclosed, and made from A-B-K laminated plastic. Scale can't reach the bearing surfaces. Lubrication by water is ample and fully controlled; yet oil or grease can be easily added to prevent rust during mill shutdown.

Thus to A-B-K material's advantages of longer bearing life, exceptional resistance to shock and low coefficient of friction is added complete bearing protection, at all times.

Investigate A-B-K Roll Neck Bearings, Thrust Collars and Slipper Bearings. They save power, permit better holding of gauge, sharply reduce down time and maintenance costs. Various formulas are available. Write for our new folder, American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Michigan.



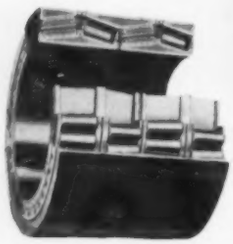
The position of the bearings on the roll neck and provisions for lubrication. "X" is the inlet port, "Y" the outlet.

Copyright 1952 American Brake Shoe Co.

AMERICAN Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

over-all service...



The responsibility of the Torrington engineer does not end with a recommendation for a particular type of anti-friction bearing. He makes every effort to "follow through" to see that the bearing continues to give the best possible performance, with a minimum of maintenance.

Over-all service—starting with the original design and continuing through in-service operation—has helped to produce the *lasting* solution to the friction problems of many manufacturers. Why not discuss *your* application with a Torrington engineer today?

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

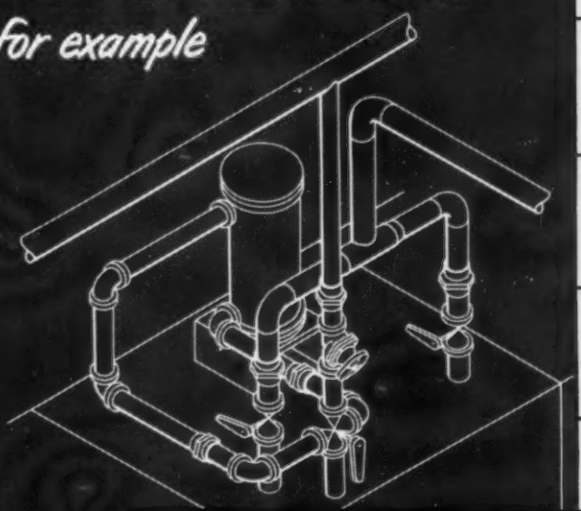
District Offices and Distributors in Principal Cities of the United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

Are Your Valves Behaving This Well?

...on River Water, for example



THE INSTALLATION

Crane Iron Body Diaphragm Valves on hydraulic lines to cylinder operators on ash pit gates; Southwark Station; Philadelphia Electric Company.

VALVE SERVICE RATINGS

SUITABILITY:	Good design for gritty fluid
FEATURES:	Neoprene disc insert-resists cutting
MAINTENANCE COST:	Making big savings here
SERVICE LIFE:	Already 6 to 9 times longer than other valves
CORROSION-RESISTANCE:	O.K. no sign of corrosion
PRICE:	Better than many ordinary valves
AVAILABILITY:	Regular number in Crane line

THE HISTORY

Valves were installed in the hydraulic system when the control cocks failed to shut off tight. But like the cocks, conventional valves put in this service didn't stand up. They couldn't handle the abrasive, sandy river water used for hydraulic operators as well as for ash pit sluicing. They leaked badly in 3 to 5 weeks; had to be replaced.

The problem was solved with Crane Iron Body Diaphragm Valves. Installed more than 7 months, there's been no leakage since; no valve trouble of any kind. The Neoprene disc insert and wide, flat seating surfaces in Crane Valves show no effect of abrasion. Their completely sealed bonnet keeps working parts free of grit.

THE VALVE

In Crane Packless Iron Body Diaphragm Valves, the Neoprene diaphragm acts as bonnet seal only; is not subject to crushing and rapid wear. Separate disc with Neoprene insert shuts off flow even should diaphragm fail. Made unlined or with full Neoprene body lining. Well suited for erosive fluids, sludges, slurries; also for many corrosive services. See your Crane Catalog or call your Crane Representative.

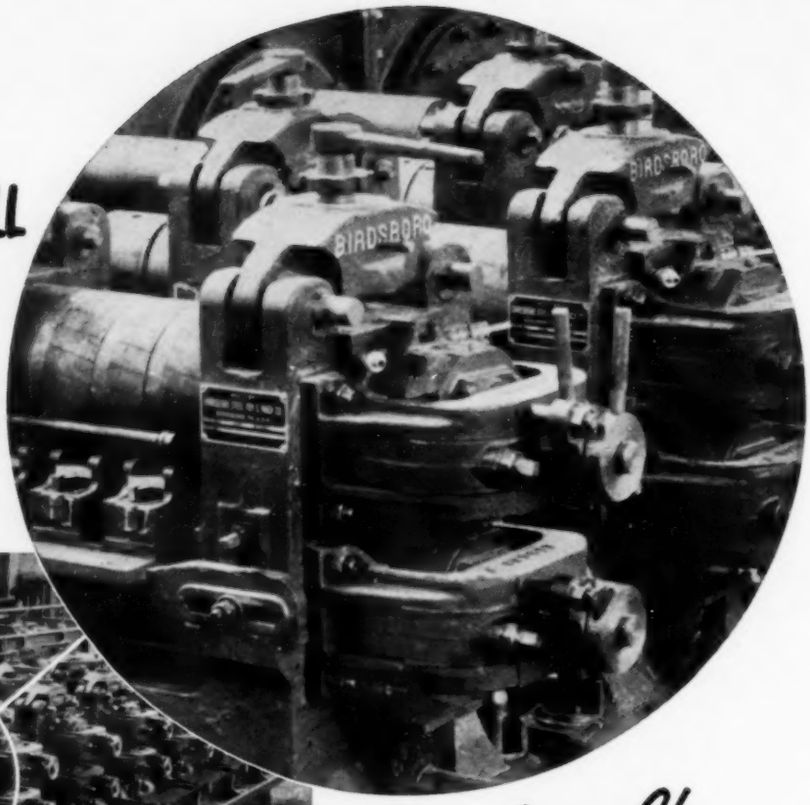
The Complete Crane Line Meets All Valve Needs. That's Why
More Crane Valves Are Used Than Any Other Make!

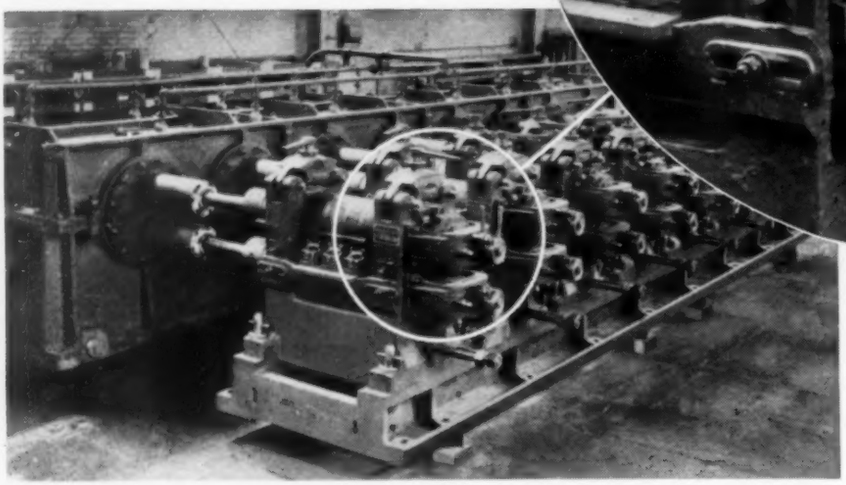
CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

NEW ROLLER-BEARING END ROLL *Reduces Downtime*





Steps Up Production

**End roll adjustment patent applied for.*

● The greatest improvement in end roll mechanism made in years . . . permits more accurate and faster end roll adjustment; more flexible operation and minimum maintenance.

The roller bearing is locked to the end of the roll, but may be changed in a jiffy—need not be removed for dressing or until the roll is scrapped. When rolls need changing, patented tilting caps swing up and rolls are raised through top of housing without disassembling end roll adjustment.*

Heavy C clamps secure the bearing housing to the frame with self-aligning surface contact for easy vertical adjustment without wear of clamping surface.

This advanced design typifies the Skill and experience of Birdsboro engineers. We'll be glad to apply our engineering service to your mill machinery problems anytime you say the word.

MM-20-51-R

BIRDSBORO

STEEL FOUNDRY & MACHINE CO.

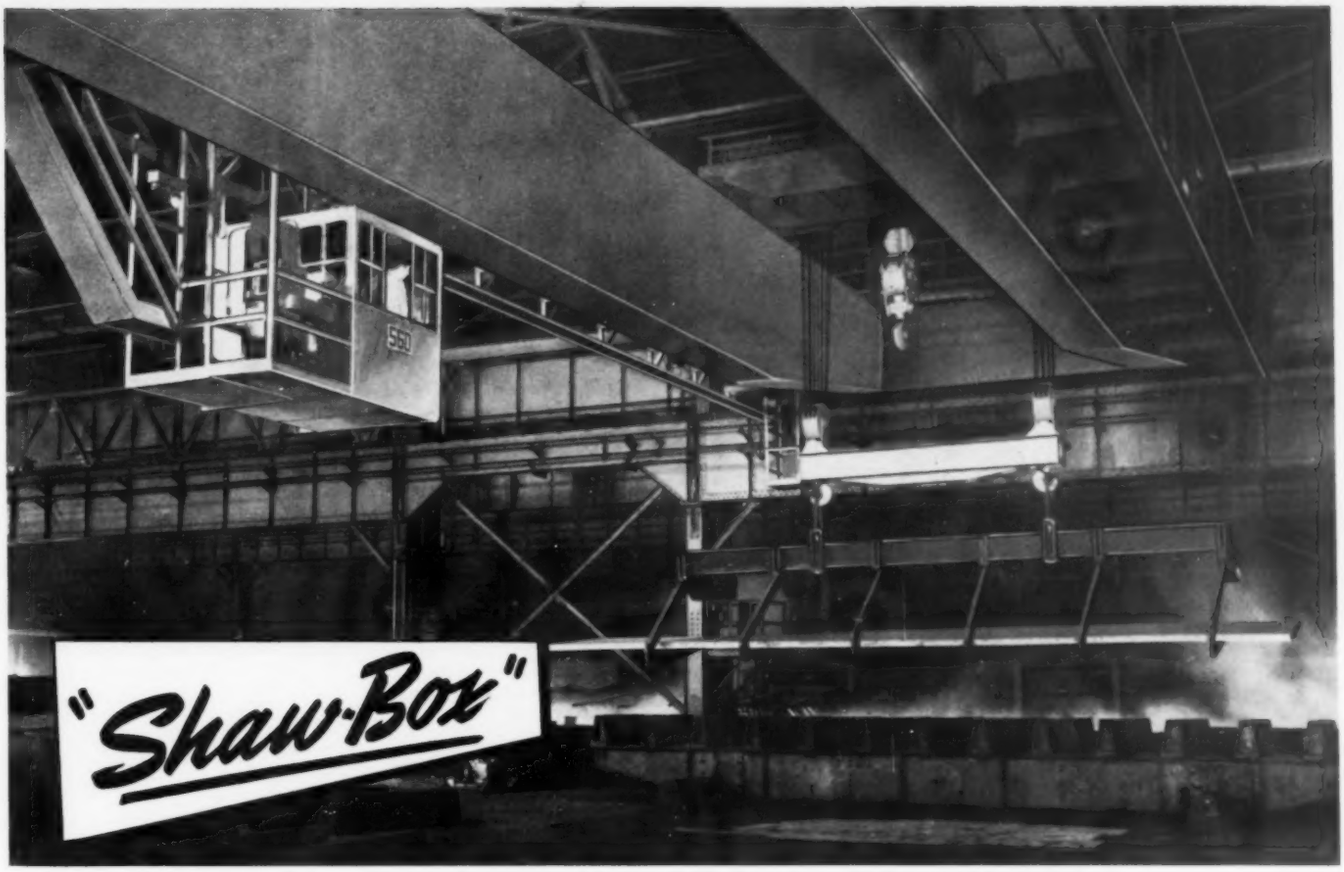
Birdsboro, Penna.

STEEL MILL MACHINERY

Designers and Builders of:

Steel Mill Machinery • Crushing Machinery • Rolls
Hydraulic Presses • Special Machinery • Steel Castings

Offices in:
Birdsboro, Pa.
and
Pittsburgh, Pa.



STEEL MILL CRANES

When the cranes in your steel mill are built by "Shaw-Box" to A.I.S.E. or individual mill specifications, you have rugged, precision engineered equipment that assures dependable, trouble-free service for years to come. The fine workmanship and specialized design details, that are basic in "Shaw-Box" crane construction, insure you low-cost performance under the most severe operating conditions with minimum attention for maintenance.

The plus advantages of long experience, advanced engineering techniques, and modern manufacturing methods result in low production costs that are reflected in attractive prices.

"Shaw-Box" Steel Mill Cranes are recognized and respected for these qualities and for their impressive records of reliable service and performance in mills all over the country. Each is an outstanding example of fully interpreted A.I.S.E. or individual mill specifications.

That is why, for the work they do, they are the greatest value in dependable crane service your purchase dollar can buy.

BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX."

SHAW-BOX CRANES

MANNING, MAXWELL & MOORE, INC. MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

Are Your Profits Going Up In Smoke?

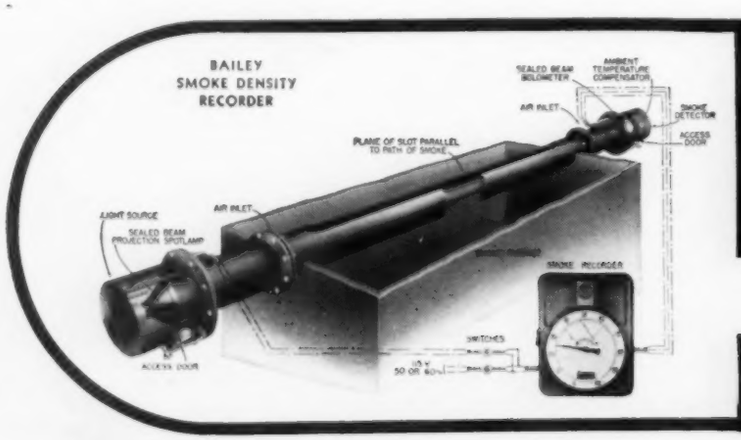
Let Bailey Controls Help Cut Down Your Production Losses

Process materials or fuels that go up the stack as dust or products of incomplete combustion are the same as money thrown to the four winds. But unlike money, this air pollution is not welcome in your community.

Your local Bailey Engineer can help you reduce this waste—and improve your relations with smoke prevention officials. The solution he offers will be based on many years of Company experience in the burning of commercial and waste fuels. He has information which will help you to arrive at the best control set-up for fuels, fired singly or in combination in a wide variety of furnaces, heaters, kilns, ovens and dryers.

His selection of meters and controls for your needs is based on a *complete* line of equipment. He can offer you Fuel—Air Ratio Meters or Gas Analyzers; Pneumatic or Electric Telemetering; Orifices, Flow Nozzles, Venturis or Weirs; full size or miniature instruments —and an infinite selection of automatic control systems from which to choose the one best suited to the operation of your process.

Bailey Engineers are located in almost every large industrial center. A call to our nearest office is a good first step in the solution of your fuel economy and smoke prevention problems. P-25



BAILEY METERS

BAILEY METER COMPANY

1047 IVANHOE ROAD
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Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

WORM GEARING — universal in its application — affords advantages for almost every power transmission job. Select worm-gear units to meet your need from the complete Cleveland line. Write now for new 180-page Catalog 400, just off press.

Photo of Michigan Crane & Conveyor parts-loader in the Commonwealth Industries, Inc., plant at Detroit, by courtesy of The Iron Age.

CLEVELAND helps increase furnace output 10%

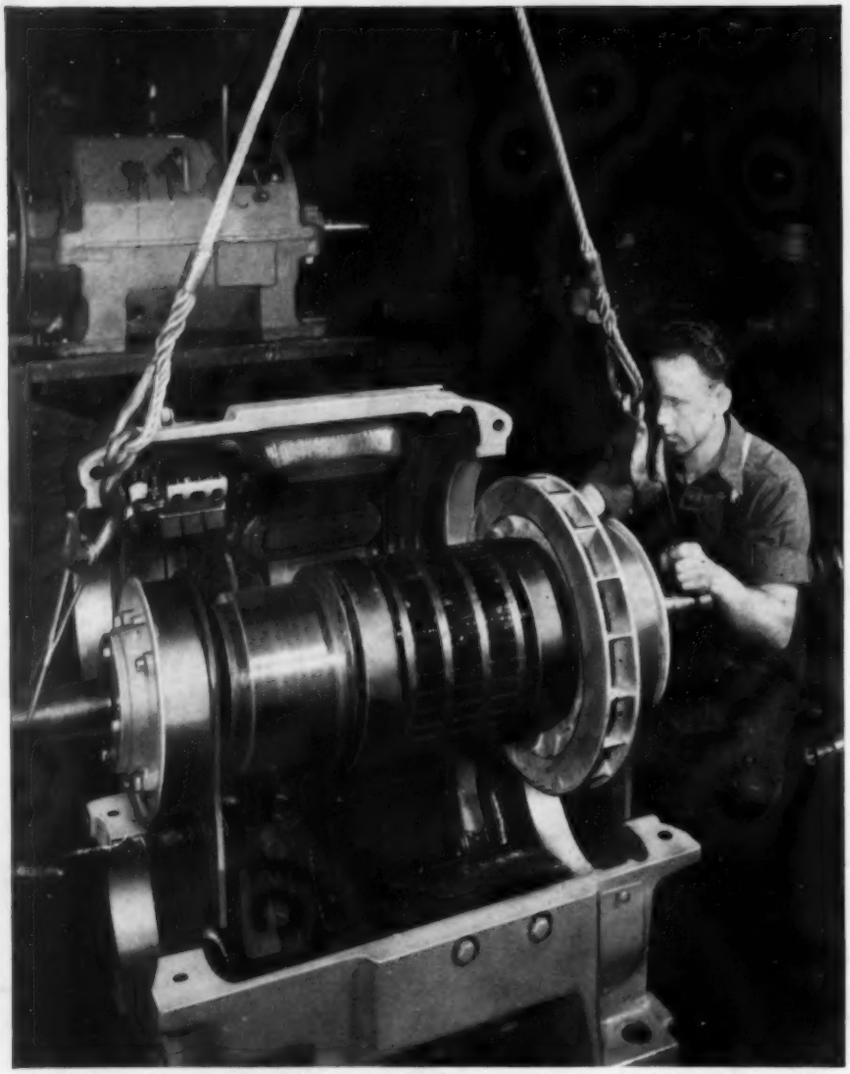
DRIVING a conveyor that loads small parts into a continuous heat treat furnace 24 hours a day is punishing service. That's why Commonwealth Industries turned to a long-lasting, trouble-free Cleveland. Set up to maintain a steady, sure furnace-feeding pace, Cleveland helped increase furnace output 10% in one year's time. In addition, labor-savings of $17,500 were realized over the same year's period.

Wherever Clevelands serve—and you'll find them in most industries—engineers will tell you that Clevelands do their work under heavy loads, continuously or intermittently, no matter how severe the conditions, with a minimum of attention.

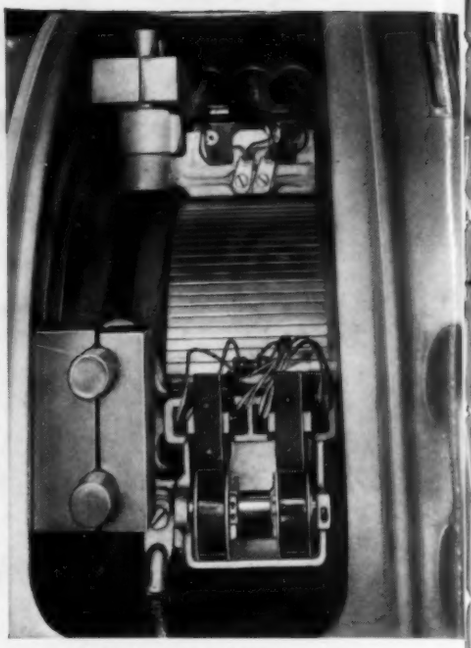
In or near your city, there's a Cleveland engineer ready to serve you. He will be glad to discuss your power transmission problems and suggest proper drives to meet your particular needs. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

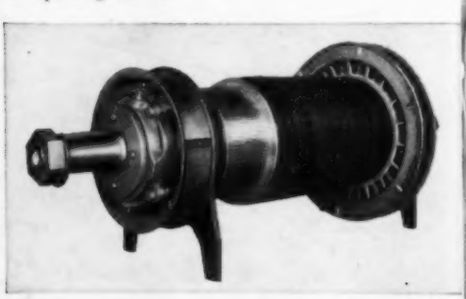
CLEVELAND
Worm Gear
Speed Reducers



HINGED TOP swings open to full 180 degrees for easy maintenance. On some larger sizes, top may be completely removed. Keys position frameheads in frame, which holds armature in place by clamping action. Thus, armature is released by opening frame.



WIDE COMMUTATOR OPENING gives easy access to entire brushholder assembly without necessity of opening frame.



MOUNTING FEET on armature frame head permit placing it directly on floor without supporting blocks, with no danger of rolling or damaging coils. Armature and commutator are assembled on a seamless steel sleeve, enabling shaft to be easily replaced without disturbing windings.

Motor built for fast, easy maintenance cuts steel-mill downtime

G-E mill motor features include long armature supporting feet, wide commutator opening, hinged top

Here's the heavy-duty mill motor—the General Electric MD-600—specifically designed to make maintenance easier, faster, and far less costly in terms of steel-mill downtime.

For example, armatures or field coils can be rapidly replaced without affecting motor-frame alignment; double-end drive shaft can be pressed out without disturbing commutator or windings; bearing cap and frame head are readily removed for disassembly and servicing of bearings; unique pressure-relief greasing system facilitates lubrication and keeps grease from entering commutator or windings.

These—and other convenience features illustrated above—are in addition to the rugged construction throughout that assures long motor life, and universal frame design that's adaptable to several types of enclosures. For complete information, contact your nearest G-E Apparatus Sales Office and ask for Bulletin GEA-4654, or write to General Electric Company, Section 659-86, Schenectady 5, N. Y.

GENERAL ELECTRIC

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

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Manhattan Building
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MOFFATT BEARINGS COMPANY
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A Complete Anti-Friction Bearing Service
Ball, Roller, Thrust and Needle

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PITTSBURGH (Continued)

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CONTRACTORS
• Construction • Rebuilds • Linings
• Maintenance • Repair
AFFILIATED FURNACE, INC.
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METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
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Park Building PITTSBURGH, PA.
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ENGINEERS AND CONSTRUCTORS
Specializing in Steel Mill Construction
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Auburn & Associates, Inc.
Engineers
ELECTRICAL LAYOUTS FOR STEEL MILLS
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

CHEMSTEEL CONSTRUCTION COMPANY, INC.
204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
Send data on Engineering & Construction facilities for
ACID-ALKALI-PROOF CONSTRUCTION
of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

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Phone: ATlantic 1-4254
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FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
SMITH—Telesmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

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SUPERINTENDENT for steel plant, Transportation and Yard Department. To qualify applicant must have had experience within an integrated steel plant. Must be familiar with the operation and maintenance of Diesel Locomotives and cranes, operation of standard intra-plant railroad system, and departmental organization. Must be a leader. The plant is located in the Mid-West; good housing conditions. In replying please give full particulars concerning experience and personal qualifications. All replies will be held strictly confidential. Personal interviews will be arranged. Reply Box No. 700, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

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10 to 15 years practical experience in designing Open-Hearth Furnaces. Write giving details to Employment Office.

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EQUIPMENT NEWS

(*Continued from page 180*)

any position. This flexibility in handling the ventilating device on the job makes it easy for workmen to use it to best advantage either outside or inside of large weldments.

Two features from the standpoint of Baldwin management are the small investment required and the fact that no time was required for the installation of extensive and expensive duct work throughout the plant. The initial cost of an air mover is about one-tenth that of an electrically driven explosion-proof blower and exhauster of similar air-handling capacity. Time saving was especially advantageous while setting up plant facilities last year for the production of Army tank hulls. Space saving in the plant was also an important consideration.

Portable air movers, operating only on a compressed air line, remove welding fumes and sparks to provide safe individual ventilation for welders working on the 80-ton side platen of a hydraulic forging press of 11,000 tons capacity.

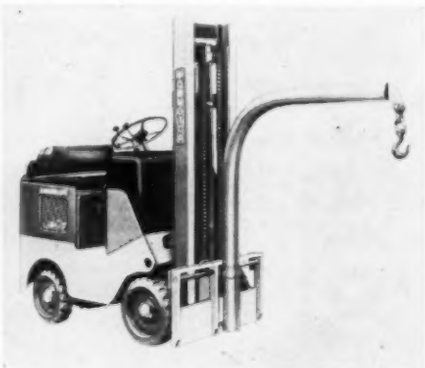
On top of these several advantages is the fact that no maintenance is required for the air movers. There are no moving parts, motors, turbines or fans. This minimizes explosion hazards in handling dust, gas-laden or heated atmospheres.

Operation is based on venturi effect produced when compressed air (or steam) is expanded at high velocity through an annular orifice and outlet horn. When operated on 20 lb air pressure the smallest models remove more than 4 cu ft per sec of air and fumes from the weld zone.

In addition to their use for fume removal, the air movers are equally as efficient for introducing fresh air into confined areas to cool the atmosphere or to establish safe working conditions.

CRANE ARM ACCESSORY

▲ New efficiency in handling cumbersome loads is realized with the Towmotor crane arm, a standard accessory developed by Towmotor Corp.



Readily interchangeable with standard Towmotor forks, the crane arm expedites plant-wide movement of heavy engines, castings, dies, long bars and similar bulky materials. In addition, the accessory facilities placing such loads into otherwise inaccessible places.

PRIMING INDUCTOR

▲ Nagle Pump Co.'s priming inductor was designed for priming of pumping systems where the pump is situated above the water level. It has rendered satisfactory performance in connection with pumps handling ashes, sand and other solids, as well as clear liquids. Basically, it is a water-operated jet, its purpose being to fill

the entrance pipe and pump with liquid so as to initiate pumping.

The priming inductor is a simple unit, requiring only a clear liquid service pipe. It is coupled to the entrance pipe of the pumping unit. A service liquid supply of sufficient capacity and pressure must be piped to it, ordinary city pressure generally sufficing. No valves are needed in either the entrance or discharge pipe. Priming is completed in just a few seconds. The inductor does not retard suction after priming has been effected and it is in stand-by service.

These units are available for use with those Nagle centrifugal pumps which are not self-priming and other makes of horizontal shaft pumps which are not self-priming. Made in thirteen sizes, to fit entrance pipes from 1½ in. to 18 in.

INDEX TO ADVERTISERS

JULY, 1952

A

Adalet Manufacturing Co., The 171
Aetna-Standard Engineering Co., The 1
Ajax Flexible Coupling Co. 166
Alliance Machine Co. 28
American Brakeblok Division, American Brake Shoe Co. 181
American Chemical Paint Co. 148
American Flexible Coupling Co. 152
American Manganese Steel Division, American Brake Shoe Co. 41
American Wheelabrator Equipment Corp. 44

B

Bailey Meters Co. 186
Bantam Bearings Division of The Torrington Co. 182
Birdsboro Steel Foundry and Machine Co. 184
Bliss Co., E. W. 46, 47
Bonnot Co. 155
Bowser, Inc. 164
Bristol Co., The 15, 151
Browning and Co., Inc., Victor R. 174
Bussmann Manufacturing Co. 130, 131
Cities Service Oil Co. 13

C

Clark Controller Co. 144
Cleveland Crane and Engineering Co., The 48
Continental Foundry and Machine Co. 7
Crane Co. 183
Crouse-Hinds Co. 22, 23
Cutler-Hammer, Inc. ..... Cover 2

D

Diamond Power Specialty Corp 156
Documentation and Licenses, Paris, France Cover 1
Drever Co. 40

E

Electric Controller and Manufacturing Co. 4, 153, 175
Electric Products Co., The 174
Electric Service Manufacturing Co. 25

F

Falcon Bronze Co. 171
Farrel-Birmingham Co. 21
Farrell-Cheek Steel Co. 45
Farval Corp., The ..... Cover 3
Flinn and Dreffein Engineering Co. ..... Cover 1
Foote Brothers Gear and Machine Co. 12
Foxboro Co., The 52
Furnace Engineers, Inc. 34, 35

G

General Electric Co. ..... Cover 4, 26, 27
Goodman Manufacturing Co. 138
Gulf Oil Corp. 143

H

Hagan Corp. 179
Hallden Machine Co., The ..... Cover 1
Heppenstall Co. 139
Homestead Valve Manufacturing Co. 29
Hyde Park Foundry and Machine Co. 169

I

Iron and Steel Exposition 6, 149
Ironsides Co., The 9

K

Koppers Co., Inc. 170

L

Leeds and Northrup Co. 11
Leslie Co. 20
Lewis Foundry and Machine Division, Blaw-Knox Co. 134
Lintern Corp. 162
Lovejoy Flexible Coupling Co 154

M

Manning, Maxwell, and Moore, Inc., Shaw-Box Crane and Hoist Division 185
Marvel Engineering Co. 147
Mathews Conveyor Co. 146
Mesta Machine Co. 5
John Miles and Partner (London, Ltd.) ..... Cover 1
Minneapolis-Honeywell Regulator Co., Industrial Division 24
Morgan Construction Co. 163
Morgan Engineering Co. 172

N

National Carbon Co., A Division of Union Carbide and Carbon Corp. 39, 160
National Electric Coil Co. 167

O

Oakite Products, Inc. 169
Ohio Electric Manufacturing Co., The 180
Okonite Co., The 159

P

Pacific Pumps, Inc. 133
Pennsylvania Transformer Co. 30, 31
Pittsburgh Lectromelt Furnace Corp. 54
Pollock Co., Wm. B. 51
Poole Foundry and Machine Co. 190
Post-Glover Electric Co. 8

R

Republic Flow Meters Co. 33
Revere Electric Manufacturing Co. 171
Roberts and Schaefer Co. 32
Ross Carrier Co., The 150
Rust Furnace Co. 129
Rust-Oleum Corp. 168

S

Salem-Brosius, Inc. 37
SKF Industries, Inc. 177
Spraying Systems Co. 176
Standard Boiler and Plate Iron Co. 42

T

Timken Roller Bearing Co., The 43
Tnemec Co. 136
Tool Steel Gear and Pinion Co. 137
Trabon Engineering Corp. 140
Treadwell Construction Co. 158
Truflo Fan Co. 178

U

Union Carbide and Carbon Corp., National Carbon Co. 39, 160
Union Steel Castings Division, Blaw-Knox Co. 132
United Engineering and Foundry Co. 19
United States Graphite Co. 18

V

Vaughn Machinery Co., The 50

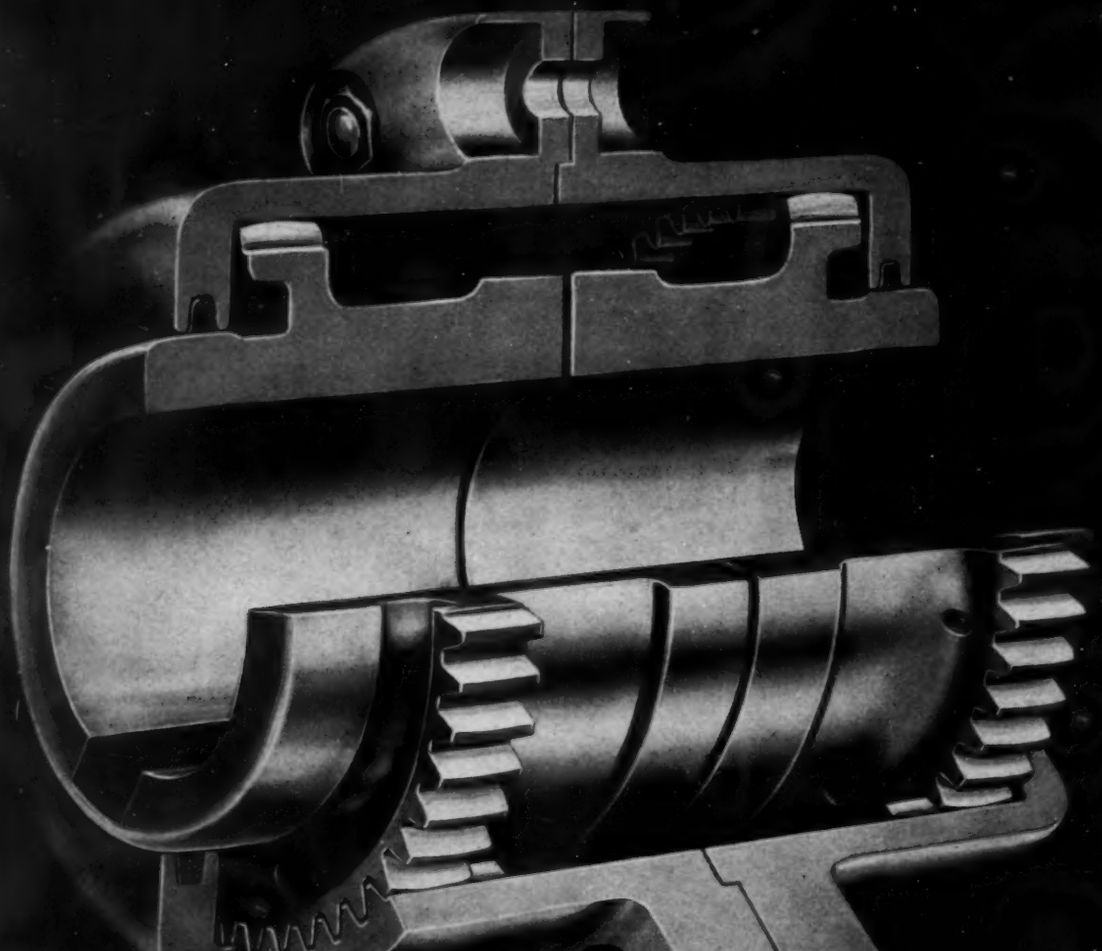
W

Wagner Electric Corp. 14
Wean Engineering Co., Inc., The ..... Cover 1
Wean Engineering Co. of Canada, Ltd., The Cover 1
Wean Equipment Corp. ..... Cover 1
Wellman Engineering Co. 38
Westinghouse Electric Corp. 2, 3, 10, 16, 17, 36

Y

Youngstown Alloy Casting Corp. 157
Youngstown Foundry and Machine Co. 165

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Farval saves time in lubrication of Electroweld Tube Mills

FORMING steel tubing at high non-stop speed was a prime consideration to the builder of this electroweld tube mill. Slow, old-fashioned hand oiling just couldn't lubricate 44 main bearings properly and still keep step with accelerated production schedules.

No wonder this manufacturer installs Farval Centralized Lubrication Systems on his fast-moving continuous mills! Farval lubricates *while the mills are in full operation,* entirely eliminating downtime for oiling and protecting the costly bearings which help keep exactly to specification the 15,000 feet of tubing put out each 8 hours.

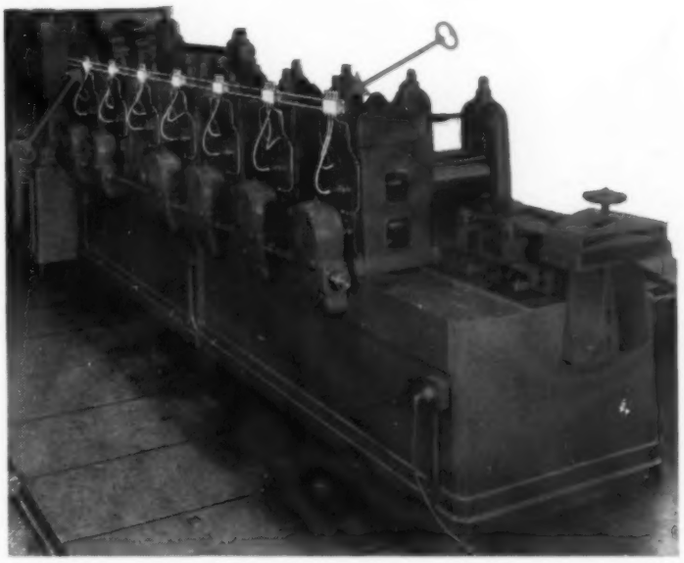
Today Farval systems safeguard millions of bearings in steel and metal working plants—on sheet and plate mills, tube and pipe mills, blooming mills—in fact, every type of equipment that must be lubricated regularly and adequately, to keep bearings on the job no matter how hard to get at.

Farval—proved in 25 years' service—is the original Dualine system of centralized lubrication that delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Indicators at every bearing show that each valve has functioned.

For a full description of time-saving Farval, write now for Bulletin 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

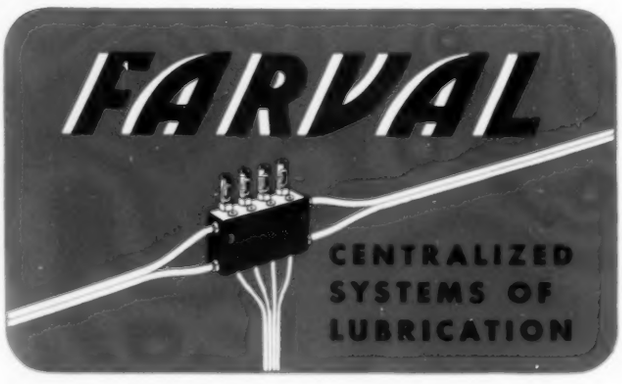
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

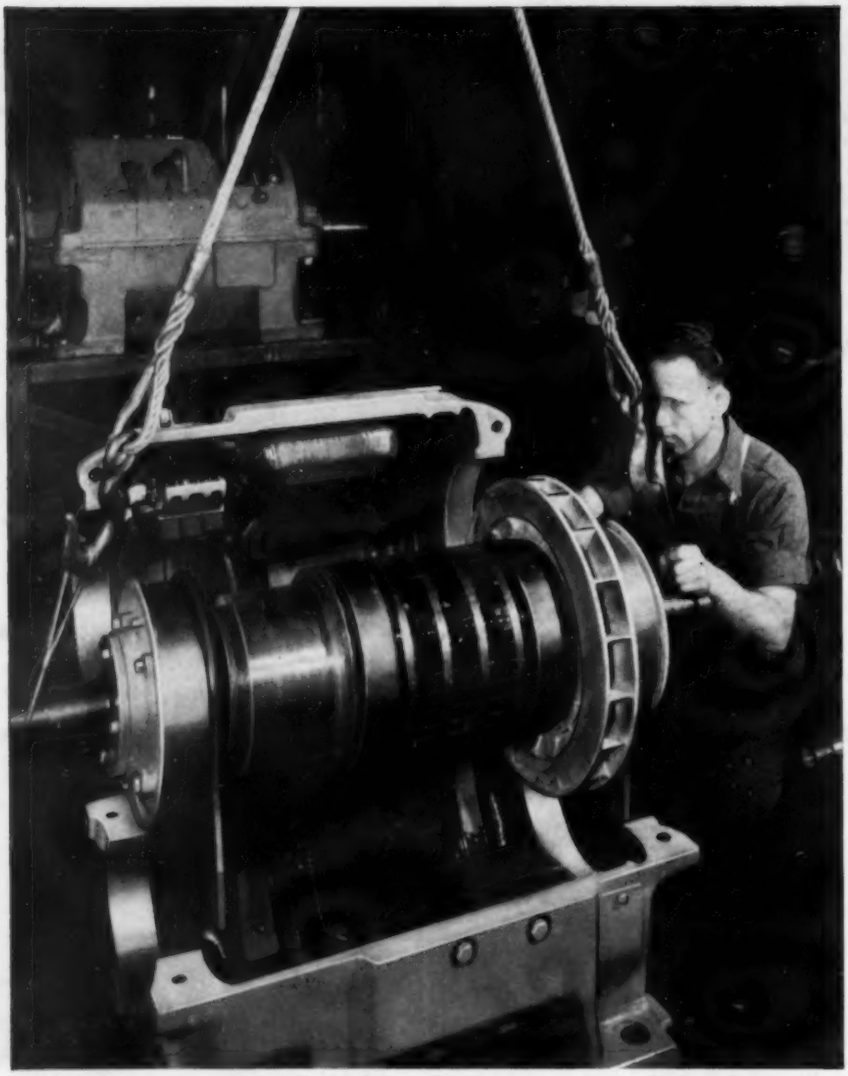
FARVAL—*Studies in Centralized Lubrication*
No. 127



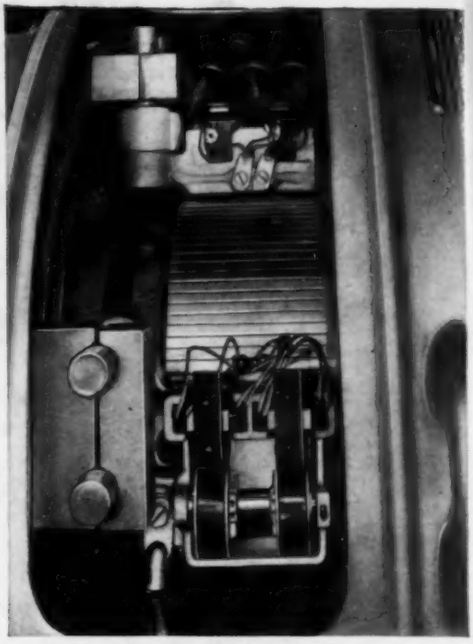
KEYS TO ADEQUATE LUBRICATION—*Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping stations—you know that a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.*

Photo by courtesy of American Electric Fusion Corporation, builder of this tube mill.

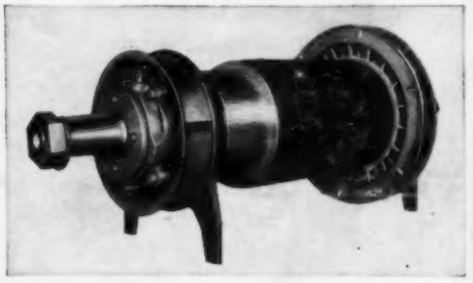




HINGED TOP swings open to full 180 degrees for easy maintenance. On some larger sizes, top may be completely removed. Keys position frameheads in frame, which holds armature in place by clamping action. Thus, armature is released by opening frame.



WIDE COMMUTATOR OPENING gives easy access to entire brushholder assembly without necessity of opening frame.



MOUNTING FEET on armature frame head permit placing it directly on floor without supporting blocks, with no danger of rolling or damaging coils. Armature and commutator are assembled on a seamless steel sleeve, enabling shaft to be easily replaced without disturbing windings.

Motor built for fast, easy maintenance cuts steel-mill downtime

G-E mill motor features include long armature supporting feet, wide commutator opening, hinged top

Here's the heavy-duty mill motor—the General Electric MD-600—specifically designed to make maintenance easier, faster, and far less costly in terms of steel-mill downtime.

For example, armatures or field coils can be rapidly replaced without affecting motor-frame alignment; double-end drive shaft can be pressed out without disturbing commutator or windings; bearing cap and frame head are readily removed for disassembly and servicing of bearings; unique pressure-relief greasing system facilitates lubrication and keeps grease from entering commutator or windings.

These—and other convenience features illustrated above—are in addition to the rugged construction throughout that assures long motor life, and universal frame design that's adaptable to several types of enclosures. For complete information, contact your nearest G-E Apparatus Sales Office and ask for Bulletin GEA-4654, or write to General Electric Company, Section 659-86, Schenectady 5, N. Y.

GENERAL ELECTRIC